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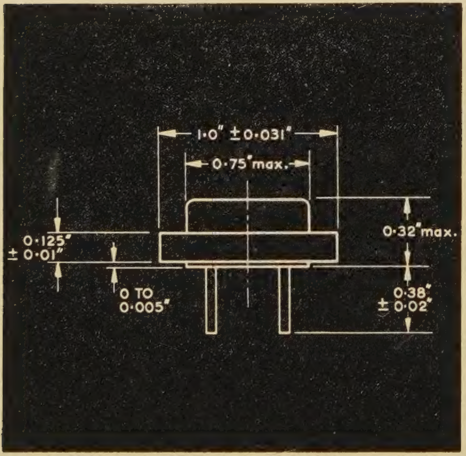
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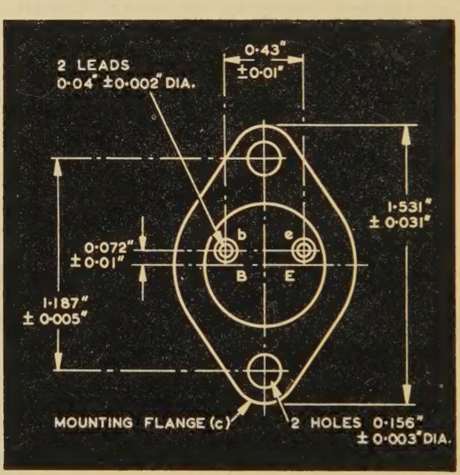
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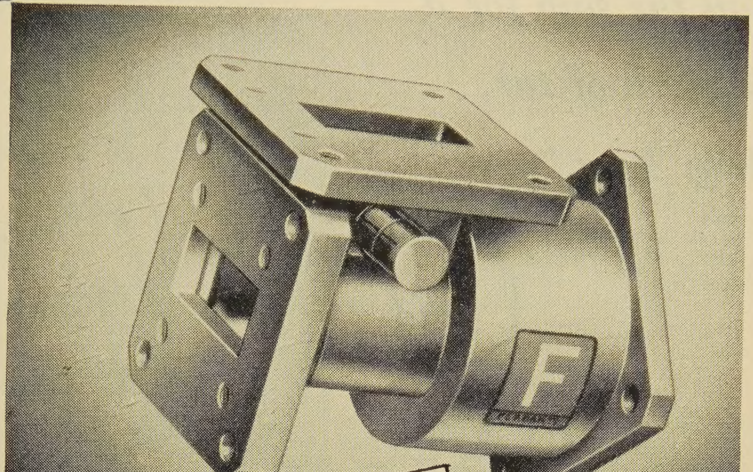

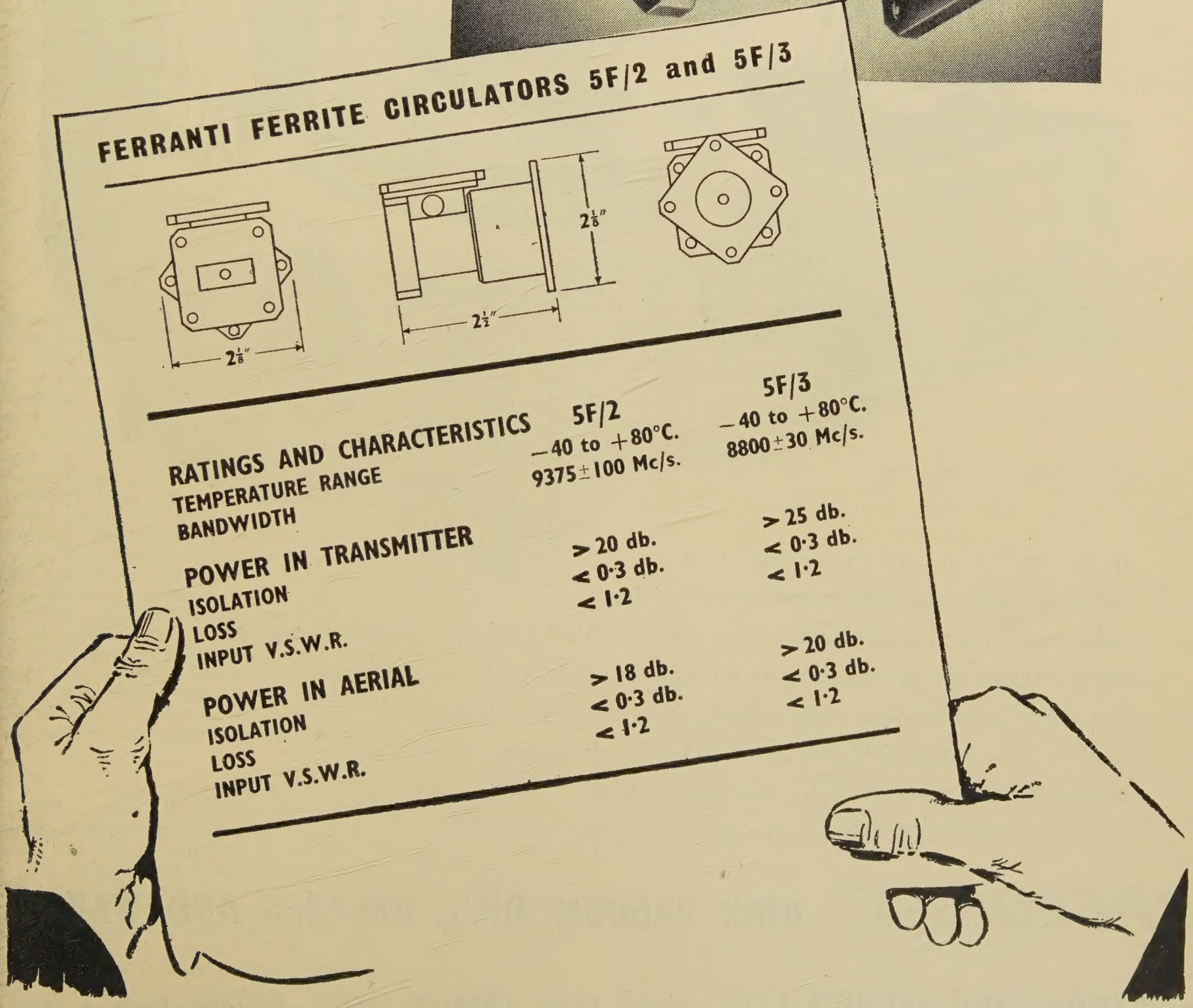

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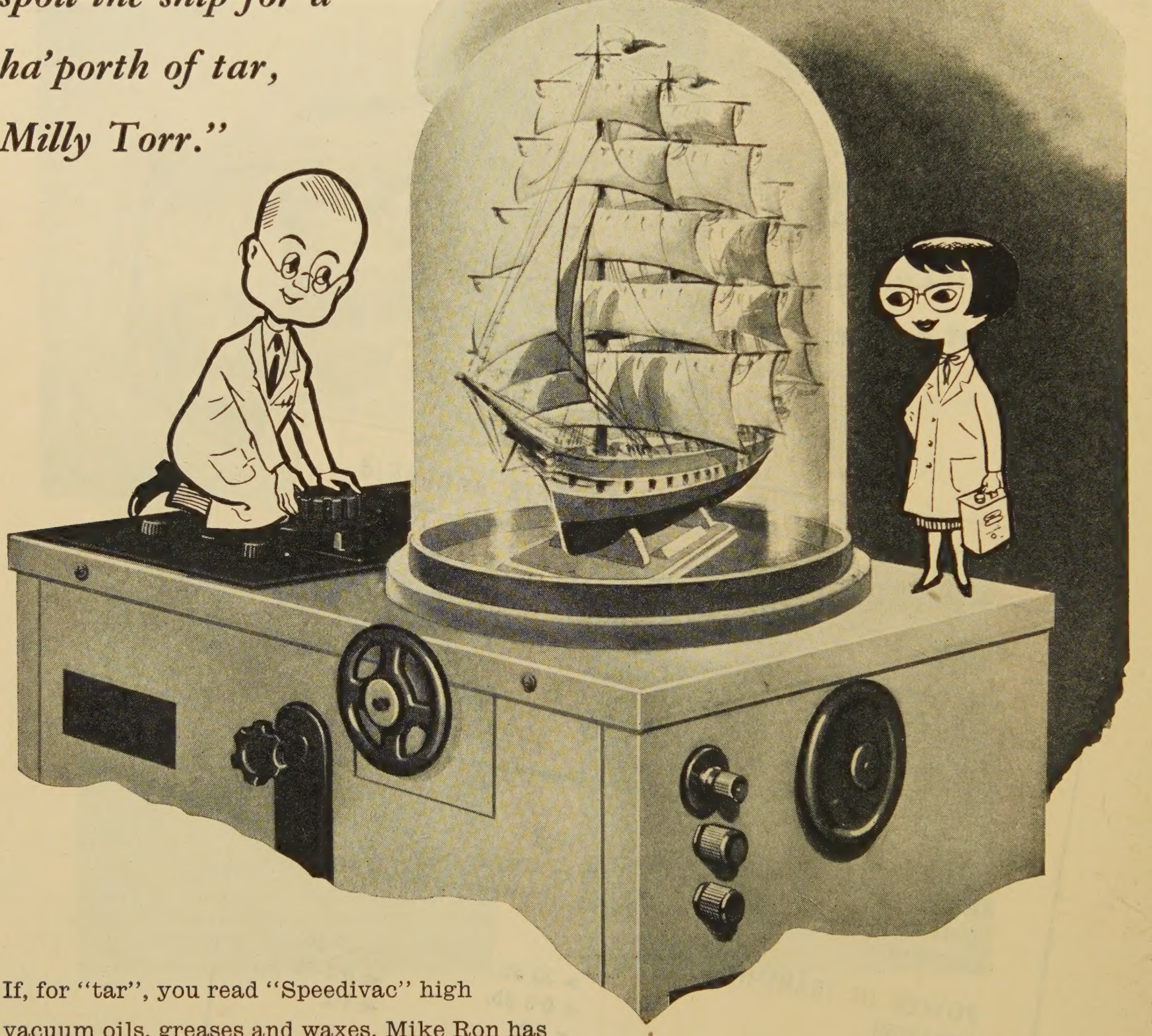

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PHYSICS ABSTRACTS

Volume 63 FEBRUARY 1960 Number 746

MATHEMATICS

517.5 : 539.16

821 METHOD FOR THE ANALYSIS OF MULTICOMPONENT EXPONENTIAL DECAY CURVES.

D.G.Gardner, J.C.Gardner, G.Laush and W.W.Meinke.
J. chem. Phys., Vol. 31, No. 4, 978-86 (Oct., 1959).

A frequently encountered problem in many branches of science involves the resolution of experimental data into a sum of independent exponential curves of the form

$$f(t) = \sum_{i=1}^{n} N_i \exp(-\lambda_i t),$$

in order to estimate the physically significant parameters N_i and λ_i. Such problems arise, for example, in the analysis of multicomponent radioactive decay curves, and in the study of the dielectric properties of certain compounds. This paper is concerned with the numerical evaluation of a mathematical approach to the problem. The approach is based on the inversion of the Laplace integral equation by a method of Fourier transforms. The results of the analysis appear in the form of a frequency spectrum. Each true peak in the spectrum indicates a component, the abscissa value at the centre of the peak is the decay constant λ_i, while the height of the peak is directly proportional to N_i/λ_i. Results obtained on an IBM 650 computer indicate that the method may possess certain advantages over previous methods of analysis.

517.9 : 534.2

822 SOLUTION OF CAUCHY'S PROBLEM FOR THE WAVE EQUATION $(\partial^2/\partial t^2 - \nabla^2 + k^2)\,\psi = 0$. S.C.Malaviya.
Proc. Indian Acad. Sci. A, Vol. 48, No. 4, 190-6 (Oct., 1958).

A method given by Copson (Abstr. 4769 of 1956) has been generalised here to obtain a solution of Cauchy's problem for the wave equation $\partial^2 u/\partial t^2 - \nabla^2 u + k^2 u = 0$ in any odd number of spatial dimensions. The method does not involve the use of any device for evaluating the divergent integrals.

ASTROPHYSICS

522.6 : 535.41

823 INTERFEROMETRY OF THE INTENSITY FLUCTUATIONS IN LIGHT. III. APPLICATIONS TO ASTRONOMY.

R.H.Brown and R.Q.Twiss.
Proc. Roy. Soc. A, Vol. 248, 199-221 (Nov. 11, 1958).

For Pt II, see Abstr. 2933 (1958). A theoretical analysis is given of the application of an intensity interferometer to the measurement of the angular diameters of stars and the performance of such an instrument is calculated for representative parameters of the apparatus. It is shown that observations with an intensity interferometer are probably limited by the inherently low sensitivity of the technique to the stars visible to the naked eye, but that the resolving power, which is determined by the limitations of radio rather than of optical technique, should be great enough to measure any star, however hot, of sufficient apparent brightness; furthermore, the operation should be substantially unaffected by atmospheric scintillation. Very cool stars of adequate apparent brightness would be completely resolved by the individual mirrors of an intensity interferometer and this fact limits the technique to stars of spectral type earlier than about K5. However, a modified form of interferometer using a single main mirror should enable this limit to be extended to bright stars of spectral type as late as M5. Some applications of an intensity interferometer to measurements of both single and double stars are discussed briefly and it is concluded that such an instrument might be of value in astronomy.

522.6 : 535.41

824 INTERFEROMETRY OF THE INTENSITY FLUCTUATIONS IN LIGHT. IV. A TEST OF AN INTENSITY INTERFEROMETER ON SIRIUS A. R.H.Brown and R.Q.Twiss.
Proc. Roy. Soc. A, Vol. 248, 222-37 (Nov. 11, 1958).

An experimental intensity interferometer was constructed with two searchlight mirrors and tested on Sirius. The correlation observed with the two mirrors close together was found to be in good agreement with that expected theoretically. This result supports the prediction, made in Pt III (preceding abstract), that the performance of an intensity interferometer should not be significantly affected by atmospheric scintillation. Observations of Sirius were carried out with four different baselines and the decrease of correlation with increasing baseline length was found to be consistent with theory. The observed results have been used to derive an experimental value for the angular diameter of Sirius which is in good agreement with the value given by astrophysical theory. The results of this preliminary experiment confirm, to a considerable extent, the general conclusions reached in Pt III.

523.14

825 FORMATION OF STELLAR ASSOCIATIONS FROM GALACTIC GAS. V.Vand.
Nature (London), Vol. 184, 441 (Aug. 8, 1959).

It is suggested that an expanding ring would form when a thin sheet of self gravitating matter is pierced by a hole; instability along the ring would lead to the formation of a circular chain of stars. R.A.Newing

523.16

826 VARIABLE SPACING TWO AERIAL INTERFEROMETER OF THE RADIO-ASTRONOMY STATION OF NANÇAY. J.Lequeux, É.Le Roux and M.Vinokur.
C.R. Acad. Sci. (Paris), Vol. 249, No. 5, 634-6 (Aug. 3, 1959). In French.

A description of a two-aerial interferometer operating at 21 cm. The aerials are situated on a railway track in the form of a cross, the length of the track being 1500 metres in an east—west direction and 400 metres north—south. The maximum spacing corresponds to a lobe separation of 25 seconds of arc. The two aerials are connected by cable links to a correlation type receiver which is more sensitive than a conventional interferometer. The source is tracked over the sky and successive fringes integrated enabling the detection of sources as weak as 10×10^{-26} watt/m^2 per c/s. C.Hazard

523.16

827 THE NORTH—SOUTH ARM OF THE LARGE INTERFEROMETER AT NANÇAY.

A.Malinge, E.J.Blum, M.Ginat and M.Parise.
C.R. Acad. Sci. (Paris), Vol. 249, No. 20, 2009-11 (Nov. 16, 1959). In French.

To extend the measurements made with the east—west interferometer at Nançay, it has been extended by constructing a linear array of eight mirrors, each 10 metres in diameter and spaced at regular intervals along a north—south baseline 770 metres long. The system operates at a frequency of 169 Mc/s. Provision is made to adjust the declination of the central fringe to the neighbourhood of the source being observed and also to swing the lobe pattern about this selected position. The position of the central fringe at any instant is known and hence the instrument can be used to find accurate declinations of the sources studied. In conjunction with the east—west arm of the interferometer it has been used to make daily observations of the sun for the positioning of the sources of solar emission. C.Hazard

523.16

828 RESOLVING POWER OF THREE ANTENNA PATTERNS DERIVED FROM THE SAME APERTURE.

A.E.Covington and G.A.Harvey.
Canad. J. Phys., Vol. 37, No. 11, 1216-29 (Nov., 1959).

Three aerial patterns are derived from the same linear aperture and may be described in terms of an angular spectrum of spatial frequencies ranging from zero to a common cutoff frequency. The band passes according to the shape of the spectrum are rectangular, triangular, and cosinusoidal for the three patterns, and give resolving powers respectively of 1.33, 1.00, and 1.05, in terms of the cutoff period. The rectangular band pass gives rise to the optimum aerial pattern and allows the Fourier components of a source from zero to cutoff frequency to be received with equal intensity and zero phase shift. Scanning curves of two equally intense point sources and a uniformly bright line are investigated.

523.16

829 A SURVEY OF RADIO SOURCES AT A FREQUENCY OF 159 Mc/s.

D.O.Edge, J.R.Shakeshaft, W.B.McAdam, J.E.Baldwin and S.Archer.
Mem. Roy. Astron. Soc., Vol. 68, Pt 37-60 (1959).

The Cambridge four-element interferometer has been used at a frequency of 159 Mc/s to determine positions and flux densities for 471 radio sources lying between declinations −22° and +71°. Information concerning the angular diameters of some of the brighter sources has also been obtained and the majority of these have diameters less than 6'. Most sources have an isotropic distribution but there is a concentration of the intense ones towards the galactic plane. There is also evidence for an excess of sources in the region of the belt of background radiation crossing the galactic plate at $l = 0^\circ$. If the number-flux density distribution is compared with that expected from a uniform distribution of source in space, a deficit of the more intense sources is found.

523.16

830 THE POSITIONS, FLUX DENSITIES AND ANGULAR DIAMETERS OF 64 RADIO SOURCES OBSERVED AT A FREQUENCY OF 178 Mc/s. B.Elsmore, M.Ryle and R.R.Leslie.

Mem. Roy. Astron. Soc., Vol. 68, Pt II, 61-67 (1959).

Measurements have been made at a frequency of 178 Mc/s of the positions, flux densities and angular diameters of 64 radio sources between declinations +65° and −06°, both to provide a system of references sources and to aid in further search for optical indentifications. The observations were made with a transit interferometer in which one aerial had dimensions 1450 ft × 65 ft; this element was separated by 2570 ft from a second smaller aerial mounted on a North—South railway track 1000 ft in length. In the present measurements, observations of each source were made with eight different positions of the movable aerial and the declination was derived from the relative phases of the interference patterns recorded with the different positions. The right ascension was determined in the usual way from the mean of the observed phases. The average probable errors of the 64 positions are ±1" .5 in R.A. and ±1'.5 of arc in declination. The optical identification of six of the sources has been confirmed by these observations.

523.16

831 THE DISTRIBUTION OF RELATIVISTIC ELECTRONS IN THE GALAXY AND THE SPECTRUM OF MAGNETIC BREMSSTRAHLUNG RADIO-EMISSION. S.I.Sȳrovatskii.

Astron. Zh., Vol. 36, No. 1, 17-32 (1959). In Russian.

The problem of the diffusion of particles is solved, taking into account the regular changes of the energy of the particles during this process. The space distribution and energy spectrum of the electrons were found using simple assumptions. The corresponding intensity of the magnetic bremsstrahlung was also calculated. A diffusion coefficient $D = 10^{29}$ cm/sec and an intensity $Q = 10^{38}$ erg/sec of the sources provides for an agreement with the observed non-thermal radio-frequency region $\nu > 10$ Mc/s. P.Roman

523.16

832 ANOMALOUS CONTINUUM RADIATION FROM JUPITER. E.E.Epstein.

Nature (London), Vol. 184, 52 (July 4, 1959).

Radio observations near 21 cm wavelength indicate a variable source of nonthermal radiation in the direction of Jupiter. H.J.A.Chivers

523.16

833 THE DETECTION OF COHERENT HARMONICS IN CERTAIN SOLAR OUTBURSTS. R.C.Jennison.

Observatory, Vol. 79, 111-13 (June, 1959).

An equipment was constructed which could establish whether received radio signals were accompanied by coherent harmonics. Apart from signals of man-made origin, a series of solar outbursts were found to contain a correlated first harmonic. The quiet sun and principle radio sources did not exhibit coherent harmonics. H.J.A.Chivers

523.16 : 535.1

834 A RADIO-ASTRONOMICAL TEST OF THE BALLISTIC THEORY OF LIGHT EMISSION.

L.R.O.Storey and R.S.Lawrence.
Observatory, Vol. 79, 150-1 (Aug., 1959).

It is shown that existing radio-astronomical measurements refute the ballistic theory of light emission, as revived and modified by Dingle, unless supplemented by some further arbitrary assumption, for example, the red-shift does not indicate a true recession. T.R.Carson

523.4

835 DISTRIBUTION OF DENSITY IN A PLANETARY EXOSPHERE. I. E.J.Öpik and S.F.Singer.

Phys. of Fluids, Vol. 2, No. 6, 653-5 (Nov.-Dec., 1959).

A theory has been developed which gives the distribution of density with altitude for a planetary exosphere in the absence of local thermodynamic equilibrium. It gives values considerably lower than those conventionally calculated on the basis of the hydrostatic equation. The results apply to the case where the field of force is gravitational; hence in the case of the earth, they give the density variation of only the neutral component of the exosphere.

523.72

836 THE DISTRIBUTION OF X-RAYS EMITTED BY THE SOLAR CORONA AND THE RESIDUAL INTENSITY DURING SOLAR ECLIPSES. G.Elwert.

J. atmos. terrest. Phys., Vol. 12, No. 2-3, 187-99 (1958). In German.

It has usually been assumed that the intensity of the ionizing radiation in the E-layer during total eclipses is proportional to the area of the optically visible solar disk. However it was found that a residual amount ΔJ of the intensity J remains. The formation of the E-layer is probably mainly due to a long-wave X-ray radiation of the corona, the distribution of which over the emitting area of the undisturbed corona is studied in this paper, taking into account the self-absorption of these lines. The value of $R = \Delta J/J$ depends on the ratio η of the apparent lunar radius to the solar radius, which may differ appreciably from one eclipse to the other. Because of the ellipticity of the corona, the radiation comes mainly from the equatorial region. Using Wahrmeier's model for the density distribution of the electrons, for the residual radiation R one finds, with $\eta = 1.02$ (valid for the eclipses of 1952 and 1954), about 17-22%, with $\eta = 1.06$ (eclipse of 1955) about 10-12%. These results may be used for an interpretation of the ionospheric observations.

523.74

837 TEMPORAL DEVELOPMENT OF PHOTOSPHERIC GRANULATION. J.Rösch and M.Hugon.

C.R. Acad. Sci. (Paris), Vol. 249, No. 5, 625-7 (Aug. 3, 1959). In French.

A time-lapse cine record of a small portion of the solar photosphere (40 × 40 seconds of arc) made with a 38 cm lens on 14 May 1959 gave a sequence of 28 high-quality frames exposed for 4-5 sec at minute intervals. Repeated projection of these images showed: (1) the growth during intervals of ~ 5 min of bright granules of initial size > 1.5 seconds of arc, with a concomitant decrease of brightness; (2) the break-up of large granules into groups of smaller, and brighter grains (size < 0.8 seconds) in 10 min; (3) the condensation of an initially faint and extensive granulation to form a smaller grain of very high brightness; (4) a sudden disappearance in situ of the smaller bright grains. The continuity of these new phenomena demonstrated that atmospheric turbulence did not distort the observations. These results show that the mechanism of granulation is much more complex than has hitherto been envisaged.

D.R.Barber

523.74

838 NON-UNIFORMITY IN THE BRIGHTNESS OF THE SUN'S DISK AT SUNSPOT MINIMUM. J.C.Bhattacharyya.

J.atmos.terrest. Phys., Vol.13, No.1-2, 43-4 (1958).

Ionospheric changes during solar eclipses show that, even at sunspot minimum, the brightness of the sun's disk is not uniform. The brightness model derived by Mitra for the 1944 eclipse includes a complete bright ring round the disk, but that given by Minnis for the 1954 eclipse does not. It is shown that the 1944 data can be explained in terms of an alternative model which does not include a bright ring but significant differences between the models for 1944 and 1954 still remain.

523.74

839 PREDICTION OF SUNSPOT NUMBERS UNTIL THE END OF THE PRESENT CYCLE. P.Herrinck.

Nature (London), Vol. 184, 51-2 (July 4, 1959).

The coincidence of sunspot numbers (13-month running mean values) in the two periods, 1749-1785 and 1918-1954 — separated by 169 years — appears highly significant. It has been used to successfully predict (November 1956) monthly sunspot numbers for the years 1957 and 1958. A still better fit is obtained by using the data of April 1954-October 1958 to predict monthly values in the period, January 1959 to January 1966 (end of the present cycle). The prediction indicates 1967 as a spotless year. D.R.Barber

523.75 : 537.59

A CORRELATION BETWEEN THE EMISSION OF WHITE LIGHT AND COSMIC RADIATION BY A SOLAR FLARE. See Abstr. 392

523.75

840 AN UNUSUAL FLARE OF 1958 AUGUST 7. J.H.Reid.

Observatory, Vol. 79, 96-8 (June, 1959).

A solar flare during which flare material was observed to be ejected across the limb of the sun is described. Experimental evidence establishing that this was a Class 3 flare is presented.

H.J.A.Chivers

523.77

841 LYMAN-ALPHA PHOTOGRAPHS OF THE SUN. J.D.Purcell, D.M.Packer and R.Tousey.

Nature (London), Vol. 184, 8-10 (July 4, 1959).

With the aid of a rocket-borne ultraviolet double grating monochromator the sun was photographed in Lyman - α light concurrently with ground-based exposures in Hα, Ca K, and white light. Comparison of the four images confirms the first results from rocket-borne equipment (1956) that Lα emission is radiated most strongly from "plages", the emission pattern resembling that in Ca K light more than in Hα. The brightest details of the Lα image correlatee closely with those in Ca K light, with a notably high contrast between Lα detail and background. Sunspot areas seen with good contrast in white light are seldom noticeable in the Lα image. The total intensity of the Lα radiation depends chiefly on the extent of the "plage" areas. And since the total area of Ca "plages" is known to attain a maximum at s.s. maximum, Lα emission should also vary significantly in the 11 yr cycle. D.R.Barber

523.78

842 NON-UNIFORMITY IN THE BRIGHTNESS OF THE SUN'S DISK DURING THE ECLIPSE OF 30 JUNE 1954. C.M.Minnis.

J. atmos. terrest. Phys., Vol. 12, No. 4, 266-71 (1958).

Previously published Norwegian and British ionospheric measurements, made during the eclipse of June 1954, showed that the solar ionizing radiation was not emitted uniformly from the whole disk. Although the brightness distributions derived from the respective data appeared to be dissimilar, it is shown that the difference is superficial and that the underlying similarity is very close. Quantitative data for the most probable distribution are given and the results are compared with the distribution calculated from observations of solar noise radiation at 10.7 cm during the eclipse.

523.82 : 551.5

843 STAR VISIBILITY IN DAYLIGHT AT HIGH ALTITUDES. A.H.Mikesell.

J. Opt. Soc. Amer., Vol. 50, No. 1, 85 (Jan., 1960).

Naked-eye observations made from a manned balloon at 40 000 ft over Minnesota, U.S.A.,on May 6-7, 1958 showed the colour of the sun-lit sky to be a deep blue, or purple. The planet Jupiter was seen as a silvery-white, sharply-defined disk showing no irradiation against the sky background. The first magnitude star, Spica, less than four degrees away from Jupiter was searched for without success. Neither was the brighter and redder star, Arcturus, located. No evidence was obtained for the reality of "nautical twilight" since third magnitude stars within thirty degrees of the sunset point could be detected quite easily within five minutes of sunset.

D.R.Barber

523.84 : 539.17

844 ABUNDANCES OF THE RARE-EARTH NUCLEI PRODUCED BY RAPID NEUTRON CAPTURE IN SUPERNOVAE. R.A.Becker and W.A.Fowler.

Phys. Rev., Vol. 115, No. 6, 1410-14 (Sept. 15, 1959).

Calculations have been carried out, following the method of Burbidge, Burbidge, Fowler, and Hoyle (Abstr. 861 of 1958), for the abundances of nuclei in the rare-earth region which are produced in the rapid neutron-capture process thought to occur in supernovae. The recently available rare-earth mass differences of Johnson and Bhanot were employed. The calculated abundances agree, in general, with those given by Suess and Urey (Abstr. 927 of 1957). The results of the computations support the work of Burbidge, Burbidge, Fowler, and Hoyle which showed the effect of spheroidal deformation above the closed shell at $N = 126$ in enhancing the production of Th^{232}, U^{235}, U^{238}, Cf^{254}, etc., in supernovae. The effect of different combinations of temperature and neutron density in enhancing certain relative abundances is discussed briefly.

523.84 : 539.17

845 ROLE OF FUSION CHAIN REACTIONS IN THE NONSTATIONARY EVOLUTION OF STARS — SUPERNOVA STARS. M.Gryziński.

Phys. Rev., Vol. 115, No. 5, 1087-9 (Sept. 1, 1959).

For previous work see Abstr. 2846 (1959). The hypothesis is suggested that the cause of the explosion of supernova stars is the development of a fusion chain reaction in stellar material containing a large amount of He^3 at high densities ($\sim 2 \times 10^4$ g/cm^3). It is suggested that the conditions suitable to a strong concentration of He^3 exist only for relatively small hydrogen stars. The strength of the explosion is proportional to the amount of He^3 amassed which strongly depends on the mass of the star. The proto-stars with masses smaller than the mass of the sun lead to supernovae of type I and the proto-stars with masses equal to or greater than the mass of the sun lead to supernovae of type II. The remnant of a supernova of type I is the gaseous nebula of luminosity due to the decay of Be^7 created during the explosion in the reaction He^4(He^3,γ)Be^7.

523.85 : 538.3

TRANSFERENCE OF ANGULAR MOMENTUM BY HYDROMAGNETIC WAVES IN A PRIMEVAL NEBULA. See Abstr. 292

523.87

846 THE EFFECT OF SELF-IONIZATION AND ITS INFLUENCE ON THE INTENSITY OF CERTAIN LINES IN STELLAR SPECTRA. A.A.Nikitin.

Dokl. Akad. Nauk SSSR, Vol. 126, No. 6, 1227-8 (June 21, 1959). In Russian.

Assuming a radiation field within a star capable of ionizing an atom with the removal of an inner electron, it is possible to explain qualitatively anomalies in certain stellar spectra by considering the process of self-ionization. The effect should be particularly strong for light elements (C, N, O) and ions of Fe, whose electronic structure resembles the former. The spectra of novae, the nebula NGC 7009 and the solar corona are discussed. G.A.Chisnall

523.87

847 SATURATION EFFECTS IN VERY FAINT FRAUNHOFER LINES. C.de Jager and L.Neven.

Observatory, Vol. 79, 102-5 (June, 1959).

Absorption lines from stellar spectra can be produced under conditions of saturation, although appearing as weak lines due to veiling effects. It is suggested that very few Fraunhofer lines are truly weak lines. Using values of equivalent widths calculated for various stellar models [Recherches astronomiques de l' Observatoire d'Utrecht, Vol. 13, 4 (1957)] find the slope of the relevant portion of the "curve of growth" by examining differential effects for the lines of a multiplet. This slope is more often nearer the value of $\frac{1}{2}$, characteristic of complete saturation than the value of unity to be expected from a weak line. Saturation effects can be observed for lines with equivalent widths of as small as 0.2 mA.

523.87 : 539.17

848 COMPLETION OF THE PROTON–PROTON REACTION CHAIN AND THE POSSIBILITY OF ENERGETIC NEUTRINO EMISSION BY HOT STARS. W.A.Fowler.
Astrophys. J., Vol. 127, No. 3, 551-6 (May, 1958).

The relatively large value for the cross-section of the $He^3(\alpha,\gamma)Be^7$ reaction found experimentally by Holmgren and Johnston (1958) indicates that this reaction will complete the proton–proton reaction chain in stars which contain helium in comparable amounts to hydrogen and which operate at effective temperatures in excess of 13×10^6 degrees. Modifications to the rates of helium production and of energy generation by the proton–proton chain given by Burbidge, Burbidge, Fowler, and Hoyle (1957) are necessitated by this mode of completion of the chain. Correction factors have been calculated for several values of x_{He}/x_H over an appropriate range of temperatures. The Be^7 produced is consumed by electron capture and by proton capture, and an estimate of the relative rates of these two processes is discussed. In hot stars operating at $> 20 \times 10^6$ degrees, the proton capture forming B^8 will probably predominate, and the B^8 decay will result in the emission of energetic neutrinos up to 14.1 MeV in energy. If the proton-capture cross-section for Be^7 is relatively large, it may even be that a substantial flux of such neutrinos is emitted by the sun. The flux at the earth will be at most $\sim 2 \times 10^{+10}$ neutrinos/cm² sec. If the flux is not too small compared to this maximum value, it may be detectable through observations on $Cl^{37}(\nu,\beta^-)A^{37}$, using the techniques developed by Davis (1955).

525

849 SATELLITE TRACKING BY H.F. DIRECTION FINDER. J.L.Wolfe.
J.atmos. terrest. Phys., Vol.13, No.1-2, 155-64 (1958).

A method of satellite tracking using an h.f. direction finder is outlined and commented on. The results of tracking Sputniks I and II are given, along with an approximation of the size of error to be expected.

525

850 THE FARADAY-ROTATION RATE OF A SATELLITE RADIO SIGNAL. S.A.Bowhill.
J.atmos.terrest. Phys., Vol.13, No.1-2, 175-6 (1958).

525

851 ON THE INTERPRETATION OF THE DOPPLER EFFECT FROM SENDERS IN AN ARTIFICIAL SATELLITE. K.Weekes.
J. atmos. terrest. Phys., Vol. 12, No. 4, 335-8 (1958).

525

852 THE EFFECT OF THE IONOSPHERE ON THE DOPPLER SHIFT OF RADIO SIGNALS FROM AN ARTIFICIAL SATELLITE. F.H.Hibberd.
J. atmos. terrest. Phys., Vol. 12, No. 4, 338-40 (1958).

525

853 MAGNETIC DAMPING OF ROTATION OF SATELLITE 1958β2. R.H.Wilson, Jr.
Science, Vol. 130, 791-800 (Sept. 25, 1959).

From over 200 observations of the decreasing spin rate of Vanguard I made during the year since its launching, eddy-current induction theory yields 0.115 ± 0.001 G as the mean magnetic field normal to the spin axis of the satelite. This measured value agrees with that deduced from Bauer's model of the earth's dipole field.

525 : 621.396.946

854 RADIO OBSERVATIONS WITH SATELLITE 1958 δ OVER AUSTRALIA.
A.J.Herz, K.W.Ogilvie, J.Olley and R.B.White.
Nature (London), Vol. 184, 391-5 (Aug. 8, 1959).

This is a preliminary analysis based on an incomplete knowledge of the telemetry system. It is suggested that there is a minimum in the intensity of radiation at a latitude of 35°S, and that this could correspond to the gap between the inner and outer radiation belts. There is some evidence of a time variation in the radiation intensity. H.J.A.Chivers

529

855 FREQUENCY STANDARDS. B.Decaux.
Astron. J., Vol. 64, No. 3, 116-19 (April, 1959). In French.

Atomic standards have not replaced quartz standards, but enable considerable increases in accuracy to be effected when applied as controls for clocks operated by quartz crystals. By suitable choice of dimensions and by operation in the region of absolute zero, the crystal lives are greatly prolonged. A resonator with an atomic caesium beam has been used to give results consistent within a few parts in 10^{10} and is now available commercially. Ammonia masers have been used as generators of current of standard frequencies, but do not yet appear to have the same accuracy as caesium-controlled methods. It is premature to base a new definition of the unit of time on these standards, but they will lead to increased knowledge of the behaviour of present standards of time. N.Corcoran

PHYSICS

GENERAL

53

856 THE EDUCATION OF AN AMERICAN SCIENTIST: H.A.ROWLAND, 1848-1901. S.Resneck.
Amer. J. Phys., Vol. 28, No. 2, 155-62 (Feb., 1960).

The primary interest of this article lies in disclosing the circumstances and influences which combined to help, or hamper, the preparation of a young man for a career in science nearly a century ago. Rowland's particular case is, of course, highly individual and personal, but it also presents overtones reflecting the relevant conditions of the American social and educational scene in the last century. It illustrates how a young man, endowed with a natural talent, actuated, above all, by an early zeal for science, was able to acquire such formal training as was then available, but largely created his own opportunities for extracurricular experimentation and self-education. Good fortune and bold venturesomeness also played their part in enabling this obscure young student of physics to achieve early professional recognition through contact with Clerk Maxwell and Helmholtz, and to become, at twenty-seven, a member of the academic group assembled by President Gilman for a new venture in graduate education and research at the Johns Hopkins University.

53

857 ROLE OF PHYSICS IN REVISION OF ENGINEERING CURRICULA. V.L.Parsegian.
Amer. J. Phys., Vol. 28, No. 2, 134-8 (Feb., 1960).

It has been said that engineering education has been over-specialized, compartmentalized, and insufficiently founded on fundamentals, not only with respect to engineering courses but equally in the basic science courses. Improvements are being attempted through reorganization and integration of engineering science materials, given as common courses in categories such as thermodynamics, fluid mechanics, materials and solid state, etc.
Science courses must also eliminate compartmental thinking. Students need more than the elements and concepts of basic science in a limited frame of reference; they must achieve quantitative understanding of the interrelationship and underlying unity of the laws of nature, through a wide range of natural phenomena. Transition and translation from micro to engineering macro realms, from physical to chemical to biological phenomena, must be made meaningful in a quantitative sense. The role of physics is not to teach engineering mechanics or electrical circuitry, but the phenomena that underlie and introduce these effectively. There is particular need to stress and to take examples from atomic systems as far as possible, even with freshman physics.

53

858 THE MATHEMATICAL FORM OF PHYSICAL LAWS. CHANGES OF UNITS, INVARIANCE OF THE EQUATIONS, DIMENSIONAL ANALYSIS. R.Saint-Guilhem.

Rev. gen. Elect., Vol. 68, No. 9, 533-54 (Sept., 1959). In French.

It is shown that starting simply from the principle that units of measurement can be chosen arbitrarily, a theory of invariance, in an affine transformation, of the mathematical relations representing physical laws, can be established. The theory is developed, and applied and illustrated by numerous examples.
S.Weintroub

53

859 PRESENT STATUS OF PRECISE INFORMATION ON THE UNIVERSAL PHYSICAL CONSTANTS. HAS THE TIME ARRIVED FOR THEIR ADOPTION TO REPLACE OUR PRESENT ARBITRARY CONVENTIONAL STANDARDS? J.W.M.Du Mond.

I.R.E. Trans Instrumentation, Vol. I-7, No. 3-4, 136-74 (Dec., 1958).

The author discusses the sources of information from which the data, published by Dr. Cohen and himself in 1955 (Abstr. 2330 of 1956) were prepared; considering the weak points in the former evaluations and giving information on new re-evaluations. The author concludes that the time is not propitious for abandoning the arbitrarily defined units since these can be measured and compared with a reproducibility much superior to that for any desired Universal Constants. The author considers the four primary constants:- Sommerfeld's fine structure constant, the electronic charge, Avogadro's Number, and the conversion factor from X units (Siegbahn) to milliangstroms. Tables of values of auxiliary constants are given.
E.G.Knowles

53

860 LABORATORY EXPERIMENT FOR MEASURING SEVEN ATOMIC CONSTANTS. C.C.Sartain.

Amer. J. Phys., Vol. 27, No. 8, 605-6 (Nov., 1959).

The author describes an undergraduate experiment for the determination of: The Faraday (F), the mass (m) of an oxygen atom, the mass (M_a) of one atomic mass unit, Avogadro's number (N_0), Boltzmann's constant (k), the universal gas constant (R), and the volume (V) of one mole of gas at standard conditions. The experiment is that of the electrolysis of water, measuring the current (I), the time (t), the mass of oxygen liberated (M) at pressure (p), volume (v) and absolute temperature (T). The atomic mass of oxygen is 16 by definition and the electronic charge (e) is assumed. A few practical details are given.
E.G.Knowles

53

861 LENGTH AND TIME IN THE PROBLEM RANGE OF THE PHYSIKALISCH-TECHNISCHEN BUNDESANSTALT (PTB). U.Stille.

Z. angew. Phys., Vol. 11, No. 8, 316-23 (Aug., 1959). In German.

A review in which the units, standards and methods of measurement of length and time, with particular reference to the practice at the PTB, are briefly surveyed. Some 150 references.
S.Weintroub

53

862 SEARCH FOR A FUNDAMENTAL LENGTH IN MICROSCOPIC PHYSICS. W.A.McKinley.

Amer. J. Phys., Vol. 28, No. 2, 129-34 (Feb., 1960).

This paper reviews some of the attempts to introduce into microscopic physics a constant of fundamental length. These theories aim to restrict the notion of localizability in the domain 10^{-13} cm or smaller in an effort to remove the well-known divergences which arise in modern field theory.

53

863 THE ROLE OF AXIOMATICS IN PHYSICS, ILLUSTRATED BY THE EXAMPLE OF THERMODYNAMICS. G.Falk.

Naturwissenschaften, Vol. 46, No. 16, 481-7 (1959). In German.

An axiomatic formulation of a physical theory may lead to important modifications and generalizations. The two laws of thermodynamics, together with Nernst's theorem, are replaced by three axioms whose applicability is not restricted to thermal systems.
R.A.Newing

53

864 USEFUL APPROXIMATIONS IN WIENER–HOPF PROBLEMS. G.F.Carrier.

J.appl. Phys., Vol.30, No.11, 1769-74 (Nov., 1959).

Frequently, the only serious obstacle which prevents one from obtaining a physically interpretable solution to a Weiner–Hopf problem is the explicit factorization of the "kernel" of that problem. A technique whereby an easily factored kernel replaces the original without serious loss of accuracy is illustrated by several examples.

53

865 LIMIT OF USEFULNESS OF REPEATED MEASUREMENTS. R.I.Yanus.

Fiz. Metallov i Metallovedenie, Vol.4, No.2, 369-74 (1957). In Russian.

It is shown that Gogoberidze and Kirillov's opinion, that repeated measurement of a particular quantity by the same instrument can reduce the probable random error of the measurement only to the error in reading the indication of the instrument, is valid only for those trivial cases in which the numerical results of all measurements are equal.

GRAVITATION . RELATIVITY

530.12

866 EXTENDING THE LORENTZ TRANSFORMATION BY CHARACTERISTIC COORDINATES. R.T.Jones.

Amer. J. Phys., Vol. 28, No. 2, 109-11 (Feb., 1960).

The problem considered is that of rectilinear motion with variable velocity. The paper gives, by an elementary construction, a system of coordinates which is conformal in a restricted region near the axis of the motion. In such coordinates the velocity of light remains invariant even for observers moving with variable velocity. By a particular choice of the scale relation the restricted conformal transformations can be made to reduce to the Lorentz transformation everywhere in the case of constant velocity and locally in the case of variable velocity.

530.12

867 THE SUPER-ENERGY TENSOR. R.Debever.

C.R. Acad. Sci. (Paris), Vol. 249, No. 15, 1324-6 (Oct. 12, 1959). In French.

A symmetrized form of Bel's fourth rank tensor is defined in terms of four isotropic vectors. The Petrov classification is discussed.
R.A.Newing

530.12

868 THE ELECTROMAGNETIC ENERGY–MOMENTUM TENSOR IN THE PRESENCE OF CHARGED MATTER. S.Mavridès.

C.R. Acad. Sci. (Paris), Vol. 249, No. 5, 637-9 (Aug. 3, 1959). In French.

Various tensors are constructed which reduce to a symmetrical form in the case of a Maxwellian relation between intensity and induction.
R.A.Newing

530.12

869 ANTISYMMETRIC PROPAGATORS IN GENERAL RELATIVITY. QUANTIZATION OF THE ELECTROMAGNETIC FIELD IN VACUO. A.Lichnérowicz.

C.R.Acad. Sci. (Paris), Vol. 249, No. 15, 1329-31 (Oct. 12, 1959). In French.

530.12

870 APPROXIMATE FIELD EQUATIONS IN AN EINSTEIN–SCHRÖDINGER TYPE UNIFIED THEORY. L.Bouche.

C.R. Acad. Sci. (Paris), Vol. 249, No. 15, 1321-3 (Oct. 12, 1959). In French.

The field equations are derived from the author's action density, assuming that the $g_{\underset{\vee}{\mu\nu}}$ are first order small quantities with no restrictions on the $g_{\underline{\mu\nu}}$.
R.A.Newing

530.12

871 THREE REMARKS CONCERNING A RECENT THEOREM. C.B.Rayner.
C.R. Acad. Sci. (Paris), Vol. 249, No. 15, 1327-8 (Oct. 12, 1959). In French.

See Abstr. 4255 and 9175 (1959).

530.12

872 TWO REMARKS IN RELATION TO THE PROBLEM OF THE ROTATING DISK IN THE THEORY OF RELATIVITY. L. de Broglie.
C.R. Acad. Sci. (Paris), Vol. 249, No. 16, 1426-8 (Oct. 19, 1959). In French.

The condition for the synchronization of an infinite series of infinitesimal clocks, of equal period, situated around the circumference of a circle with centre on the axis of a rotating disk, is shown to be identical with the relation which expresses the quantization of the circular motion of the clocks according to the old quantum theory. It is also agreed that, for a rotating disk, the Lorentz contraction should lead to a rupture of the disk owing to the contraction of line elements in the azimuthal direction while those in the radial direction remain unchanged. T.R.Carson

530.12

873 "STATIONARY" PHENOMENA IN THE MOVEMENTS IN CLOSED CIRCUIT. A.Metz.
C.R. Acad. Sci. (Paris), Vol. 249, No. 16, 1460 (Oct. 19, 1959). In French.

530.12

874 A SIMPLE FORM FOR THE RICCI TENSOR UNDER CONDITIONS OF RIGIDITY. C.B.Rayner.
C.R. Acad. Sci. (Paris), Vol. 249, No. 16, 1461-3 (Oct. 19, 1959). In French.

In an extension of previous work on rigid motion in the sense of Rosen, Einstein's exterior equations are reduced to a set of equations in a 3-space. R.A.Newing

530.12

875 MODEL UNIVERSES IN A STATE OF PURE RADIATION. J.Hély.
C.R. Acad. Sci. (Paris), Vol. 249, No. 19, 1867-8 (Nov. 9, 1959). In French.

Necessary and sufficient conditions for the state of pure radiation, as defined by Lichnerowicz, are established for a general class of model universes. R.A.Newing

530.12

876 ON THE SOLUTION OF THE EINSTEIN EQUATION $g_{\underset{+\,-}{\mu\nu};\rho} = 0$. G.Dautcourt.
C.R. Acad. Sci. (Paris), Vol. 249, No. 21, 2159-61 (Nov. 23, 1959). In French.

A method of solution of the unified field equations

$$g_{\underset{+\,-}{\mu\nu};\rho} = g_{\mu\nu,\rho} - \Gamma^{\sigma}_{\mu\rho}g_{\sigma\nu} - \Gamma^{\sigma}_{\rho\nu}g_{\mu\sigma} = 0$$

which constitutes a simplification of the method of decomposition of Tonnelat and a modification of the work of Einstein and Kaufman, is presented. It is shown why the method of solution using non-dissociated quantities is not applicable in the case where $4\gamma + 12\varphi = 3g$ is satisfied by the determinants γ, φ and g of $g_{\underline{\mu\nu}}$, $g_{\mu\nu}$ and $g_{\mu\nu}$.

T.R.Carson

530.12

877 RECIPROCAL STATIC METRICS AND SCALAR FIELDS IN THE GENERAL THEORY OF RELATIVITY. H.Buchdahl.
Phys. Rev., Vol. 115, No. 5, 1325-8 (Sept. 1, 1959).

A variant of the idea of reciprocal static solutions of the gravitational field equations is developed. Thus, given any static solution of Einstein's vacuum equations $R_{kl} = 0$, a one-parameter family of pairs of solutions of the field equations with scalar field, viz., $R_{kl} = -{}_{\mu}V_{;k}V_{;l}, g^{kl}V_{;kl} = 0$, can be written down by inspection. The special cases of spherical symmetry and axial symmetry are treated as explicit examples. In the former case all the solutions of the field equations are obtained in this way. The theory is discussed from a physical point of view, for which purpose the motion of a test particle in the spherically symmetric field is treated in some detail.

530.12

878 TWO MASER EXPERIMENTS TO TEST GENERAL RELATIVITY. H.Yilmaz.
Phys. Rev. Letters, Vol. 3, No. 7, 320-1 (Oct. 1, 1959).

It is suggested that the increased accuracy available with maser techniques makes it possible to test (i) the principle of equivalence, and (ii) the assumption of local isotropy in space-time, by comparing the velocities of light (i) along and perpendicular to the earth—sun line, and (ii) in the vertical and horizontal directions on the earth. R.A.Newing

530.12

879 ALGEBRAIC INTEGRALS FOR ONE-DIMENSIONAL MOTION OF AN IDEAL FLUID IN A RELATIVISTIC CASE. V.A.Skripkin.
Dokl. Akad. Nauk SSSR, Vol. 127, No. 2, 287-9 (July 11, 1959). In Russian.

Starting from an impulse—energy tensor, derived in a previous paper (Abstr. 11931 of 1959), the author considers motion of an ideal fluid under influence of an impulse. The treatment is again relativistic, but special attention is paid to algebraic analogies with classical models. Mass, energy, entropy and impulse integrals are derived and integrated. An error in the previous paper (Abstr. 11931 of 1959) is corrected. J.K.Skwirzynski

530.12

880 GRAVITATION AND ELECTROMAGNETISM. A.H.Klotz.
Nuovo Cimento, Vol. 14, No. 1, 135-41 (Oct. 1, 1959).

A unified field theory is developed from a generalized metric involving skew symmetric tensor elements. The field gravitational equations of an empty world together with the set of Maxwell's equations independent of electromagnetic vector potentials are derived from modified affine relations based on the geodesic equations. The invariants suggested by the above are used in an action integral variation similar in form to Infeld's and Plebanski's to obtain the most general relations consistent with their work on electrodynamics without vector potentials. Invariant equations resulting from a contraction of these offer a possible empirical test of the action invariants used in unified field theories.

530.12

881 SPHERICAL GRAVITATIONAL WAVES. J.Boardman and P.G.Bergmann.
Phys. Rev., Vol. 115, No. 5, 1318-24 (Sept. 1, 1959).

The field equations of the general theory of relativity are solved in the linear approximation for all cases of spherical waves with quadrupole symmetry. Energy is radiated outward by all these waves as determined by the canonical expression for the energy flux. A qualitative check of the validity of this method of calculation is made by the application of the same approximation to cylindrical gravitational radiation, for which an exact solution is known. In this case the exact and the linearized calculations lead to corresponding results.

QUANTUM THEORY

(Applications of quantum theory to elementary particles and nuclei are included under Nuclear Field Theory)

530.14

882 ON THE PROBLEM OF CAUSALITY. G.Wanders.
Nuovo Cimento, Vol. 14, No. 1, 168-84 (Oct. 1, 1959).

The possibility of formulating the causality principle in terms of observable transition probabilities is discussed. It is found that only a very weak asymptotic condition can be plausibly deduced from the causality requirement. This condition implies regularity of the forward scattering amplitude S(p) in an infinitesimal strip of the first quadrant along the real p-axis. Singularities of S(p) located at a finite distance of the real axis have also observable effects, but they cannot be interpreted as obvious acausalities.

530.14

883 ON THE THEORY OF ANGULAR OPERATORS.
S.Ciulli and J.Fischer.

C.R. Acad. Sci. (Paris), Vol. 249, No. 13, 1090-2 (Sept. 28, 1959). In French.

The S-matrix for an elementary process is developed with the help of a series of angular operators which are independent of the dynamic particulars of the reaction. The advantage of such operators lies in the fact that they permit the elimination of the angular dependence and thus lead to a system of Chew–Low equations and dispersion relations for the coefficients which depend only on the energy.

T.R.Carson

530.14

884 A MANDELSTAM REPRESENTATION IN POTENTIAL SCATTERING.
J.Bowcock and A.Martin.

Nuovo Cimento, Vol. 14, No. 3, 516-26 (Nov. 1, 1959).

The scattering from a given class of potentials including exchange forces is considered. For fixed energy one may prove the scattering amplitude is analytic in the complex cos θ plane inside the Lehmann ellipse and that each term of the Born series has the cuts and analytic behaviour conjectured by Mandelstam for the field theoretical case. A Mandelstam representation is written for each term of the Born series.

530.14

885 SCATTERING BY NONSPHERICAL PARTICLES.
J.M.Greenberg.

J. appl. Phys., Vol. 31, No. 1, 82-4 (Jan., 1960).

The small angle scattering approximation of Schiff is applied to several nonspherical body shapes. Effects of orientation and elongation are discussed.

530.14

886 QUANTUM-MECHANICAL THREE-BODY PROBLEM.
L.Eyges.

Phys.Rev., Vol.115, No.6, 1643-54 (Sept.15, 1959).

The author treats the quantum-mechanical problem of three spinless particles, with the boundary condition that the logarithmic derivative of the wave-function be a prescribed constant at each of the three boundaries $|r_1-r_2|= a$, $|r_2-r_3| = a$, $|r_1-r_3| = a$. This boundary condition is discussed; it is roughly equivalent to an interparticle potential which consists of a hard core plus a strong short-range attractive part. The eigenfunctions and eigenvalues of the system are given by the solutions of an infinite set of coupled homogeneous integral equations. The equations involve partial wave expansions in the interparticle distances and can often be truncated with good approximation by taking only a finite number of partial waves. The solution of these equations is discussed for the ground state of the system, taking relative S-waves only, for which case the infinite set of equations reduces to a single integral equation in one variable.

530.14

887 SOME EXACT SOLUTIONS OF THE TIME-DEPENDENT SCHROEDINGER EQUATION.
V.W.Myers.

Amer. J. Phys., Vol. 28, No. 2, 114-16 (Feb., 1960).

Exact solutions of the time-dependent wave equations are given for the one-dimensional motion of a particle acted on by an external force and for a forced oscillator. The solutions chosen correspond to the same time dependence for the classical momentum and for the quantum—mechanical space average of the momentum.

530.14

888 RELEVANCE OF COMPARISON OF ENERGY AS TEST OF THE ADEQUACY OF AN APPROXIMATE WAVE-FUNCTION FOR EXCITED STATES.
E.Trefftz.

Z. Naturforsch., Vol. 14a, No. 8, 708-12 (Aug.,1959). In German.

The mean energy value obtained by means of the approximate wave-function is usually compared with the experimental term value. This procedure is warranted for higher excited states only if the wave-functions are chosen orthogonally with respect to the true wave-functions of the lower excited states. It is shown how this can be accomplished in the case of wave-functions built of 1-electron functions.

F.Lachman

STATISTICAL MECHANICS
TRANSFER PROCESSES

530.16

889 ON THE FOUNDATIONS OF EQUILIBRIUM STATISTICAL MECHANICS.
M.R.Schafroth.

Helv. phys. Acta, Vol. 32, No. 5, 349-56 (1959).

Following an idea of Fierz (Abstr. 3500 of 1956), it is argued that the concepts of quantum statistics can be used to define thermal equilibrium as the state from which no change is possible without changes in the surroundings. On this view, the ergodic theorem belongs to the statistical mechanics of non-equilibrium states.

W.A.Hepner

530.16

890 LINKED-DIAGRAM EXPANSIONS FOR QUANTUM STATISTICAL MECHANICS.
A.E.Glassgold, W.Heckrotte and K.M. Watson.

Phys. Rev., Vol. 115, No. 6, 1374-89 (Sept. 15, 1959).

A general method of calculation is described for quantum statistical mechanics. It is based on a simplification of the Laplace transform of the density matrix which follows from a theorem due to Hugenholts. The basic result is that an element of the density matrix can be written as a sum over graphs, with the contribution of each graph factored into contributions from connected or linked graphs. Applied to the grand partition function, the exponential formula of Bloch and DeDominicis is obtained in a simple way. A similar formula is then derived for the canonical ensemble for the case of a nondegenerate gas. In this way the familiar result of Uhlenbeck and Beth is obtained for the second virial coefficient. Techniques are also introduced for evaluating ensemble averages of operators. In this connection, some care must be exercised in the case of diagonal operators. Finally, these methods are used to calculate the pair-correlation function for a system of fermions interacting through short-range forces.

530.16

891 STATISTICAL MECHANICS OF THE STEADY STATE.
J.A.McLennan, Jr.

Phys. Rev., Vol. 115, No. 6, 1405-9 (Sept. 15, 1959).

The description of steady-state phenomena, near equilibrium, in terms of Gibbs ensembles is discussed. The Liouville equation is modified to include external nonconservative forces which prevent the system from reaching equilibrium. The steady-state ensembles are then obtained as (approximately) time-independent solutions to the Liouville equation; such ensembles depend linearly on the thermodynamic parameters which characterize the deviation from equilibrium. With the aid of the steady-state ensembles the linear relations between the thermodynamic fluxes and forces are obtained.

530.16

892 PROOF OF THE LINKED-CLUSTER EXPANSION IN QUANTUM STATISTICAL MECHANICS.
D.J.Thouless.

Phys. Rev., Vol. 116, No. 1, 21-24 (Oct. 1, 1959).

In order to go over from a perturbation expansion of the grand partition function (the unlinked-cluster expansion) to an expansion of thermodynamic potential (the linked-cluster expansion) in powers of the interaction, it is necessary to treat carefully those terms in which creation (or annihilation) operators for the same state occur twice or more. The unlinked- and linked-cluster expansions for a system of fermions are here shown to be equivalent by a direct comparison of the terms which occur in each. The relation between the two expansions is illustrated by the example of a system of fermions interacting only with a single-particle potential.

530.16

893 AUTOCORRELATION OF QUANTUM-MECHANICAL WAVE FUNCTIONS.
R.Bourret.

Canad. J. Phys., Vol. 37, No. 9, 1062-7 (Sept., 1959).

The autocorrelation field for a system in an eigenstate is given by

$$\phi(\eta) = \Psi^*(x)\Psi(x+\eta)dx,$$

where $\Psi(x)$ is the wave-function. Some properties of this function are discussed and it is shown that its information content is intermediate between that of the wave-function and that of the partition function.

J.Hawgood.

530.16 : 538.2 : 539.2

STATISTICAL MECHANICAL THEORY OF A RANDOM FERROMAGNETIC SYSTEM. See Abstr. 674

530.16

894 GRAND CANONICAL ENSEMBLES OF GIBBS; PROOF OF THEIR UNIQUENESS, BASED ON THE INFINITE DIVISIBILITY OF THEIR RANDOM ENERGY.

B.Mandelbrot.

C.R. Acad. Sci. (Paris), Vol. 249, No. 16, 1464-6 (Oct. 19, 1959).
In French.

The standard description of the grand canonical ensemble according to statistical mechanics is compared with certain results from random-variable theory. It is claimed that the grand canonical distribution follows uniquely from three assumptions about the energy and number of particles, considered as random variables.

H.N.V.Temperley

530.16

895 THEORY OF SYSTEMS WITH A NON-CENTRAL LAW OF PARTICLE INTERACTION.

A.E.Glauberman.

Izv. Akad. Nauk SSSR, Ser. fiz., Vol. 22, No. 3, 254-9 (1958).
In Russian. English summary: PB 141041T-3, obtainable from Office of Technical Services, U.S. Dept. of Commerce, Washington, D.C., U.S.A.

Theories of interacting particles are developed, (a) for gases and liquids, with all particles assumed homogeneous and (b) for dipolar crystals, assuming a system of heterogeneous particles. These theories, based on the methods of Bogolyubov [The problems of dynamical theory in statistical physics. G.T.T.I. Moscow (1946)] are stated to give satisfactory agreement with experimental data.

J.H.Mason

530.16

896 THEORY OF MANY-PARTICLE SYSTEMS. I.

P.C.Martin and J.Schwinger.

Phys. Rev., Vol. 115, No. 6, 1342-73 (Sept. 15, 1959).

This is the first of a series of papers dealing with many-particle systems from a unified, nonperturbative point of view. It contains derivations and discussions of various field-theoretical techniques which will be applied in subsequent papers. In a short introduction the general method of approach is summarized, and its relationship to other field-theoretic problems indicated. In the second section the macroscopic properties of the spectra of many-particle systems are described. Asymptotic evaluations are performed which characterize these macroscopic features in terms of intensive parameters, and the relationship of these parameters to thermodynamics is discussed. The special characteristics of the ground state are shown to follow as a limiting case of the asymptotic evaluations. The third section is devoted to the time-dependent field correlation functions, or Green's functions, which describe the microscopic behaviour of a multiparticle system. These functions are defined, and related to intensive macroscopic variables when the energy and number of particles are large. Spectral representations and other properties of various one-particle Green's functions are derived. In the fourth section the treatment of non-equilibrium processes is considered. As a particular example, the electromagnetic properties of a system are expressed in terms of the special two-particle Green's function which describes current correlation. The discussion yields specifically a fluctuation-dissipation theorem, a sum rule for conductivity, and certain dispersion relations. The fifth section deals with the differential equations which determine the Green's functions. The boundary conditions that characterize the Green's function equations are exhibited without reference to adiabatic decoupling. A method for solving the equations approximately, by treating the correlations among successively larger numbers of particles, is considered. The first approximation in this sequence is shown to yield a generalized Hartree—like equation. A related, but rigorous, identity for the single-particle Green's function is then derived. A second approximation, which takes certain two-particle correlations into account, is shown to produce various additional effects: the interaction between particles is altered in a manner characterized by the intensive macroscopic parameters, and the modification and spread of the energy-momentum relation come into play. In the final section compact formal expressions for the Green's functions and other physical quantities are derived. Alternative equations and systematic approximations for the Green's functions are obtained.

530.16

897 MANY-BODY PROBLEM IN QUANTUM STATISTICAL MECHANICS. II. VIRIAL EXPANSION FOR HARD-SPHERE GAS.

T.D.Lee and C.N.Yang.

Phys. Rev., Vol. 116, No. 1, 25-31 (Oct. 1, 1959).

The method developed in a previous paper (Abstr. 5385 of 1959) is used to evaluate the fugacity coefficients b_l to the order a^2/λ^2 for a hard-sphere gas with spin J satisfying Bose—Einstein or Fermi—Dirac statistics.

530.16

898 PAIR DISTRIBUTION FUNCTION AND TWO-BODY PROPAGATOR.

S.Fujita.

Phys. Rev., Vol. 115, No. 6, 1335-41 (Sept. 15, 1959).

Starting from the ordinary definition of the pair distribution function, the following theorem is proved without the help of the cluster integral expansion and "toron" diagrams: the pair distribution function in the grand canonical ensemble can be expressed in terms of the two-body propagator corresponding to the scattering in position-reciprocal temperature space. A simple expression for the internal energy of a nonideal gas with pair interactions is obtained in terms of the pair distribution function.

530.16

899 GROUND STATE OF A BOSE SYSTEM OF HARD SPHERES.

Tai Tsun Wu.

Phys. Rev., Vol. 115, No. 6, 1390-404 (Sept. 15, 1959).

It is shown that the pseudopotential method can be extended to yield further terms in the low-density expansion of the ground-state energy of a system of Boltzmann or Bose particles with hard-sphere interaction. Two terms beyond the known result are found, and the expansion is no longer a power series in $(a^3\rho)^{1/2}$. Other related properties of the system are discussed.

530.16

900 WEAK-COUPLING EXPANSION FOR THE GROUND-STATE ENERGY OF A MANY-BOSON SYSTEM.

M.Girardeau.

Phys. Rev., Vol. 115, No. 5, 1090-4 (Sept. 1, 1959).

The pair theory of many-boson systems is used to obtain a weak-coupling expansion for the ground-state energy to third order in the coupling constant. The relationship of this expansion to the formal Rayleigh—Schrödinger perturbation expansion is discussed, with particular reference to the relationship between the divergent third-order term in the formal perturbation expansion and the terms of $\frac{5}{2}$ and third orders in the correct weak-coupling expansion. The excitation energy is discussed briefly; it is pointed out that the lowest-order "nonpair" correction to the phonon energy is of the right order of magnitude to cancel the spurious energy gap of the pair theory.

530.16 : 536.48

901 THE SPECTRUM OF ELEMENTARY EXCITATIONS IN A NON-IDEAL BOSE GAS.

N.M.Plakida.

Dokl. Akad. Nauk SSSR, Vol. 127, No. 2, 295-7 (July 11, 1959).
In Russian.

The difference between the exact Hamiltonian and the approximation used by Bogolyubov and Zubarev (Abstr. 5898 of 1955) is treated using second-order perturbation theory. This leads to a correction in the energy spectrum of the excitations, which is given explicitly both for very small and very large wave numbers. It is estimated that the correction amounts to 40% for liquid He^4.

O.Penrose

530.16

902 IRREVERSIBLE THERMODYNAMICS OF NONLINEAR PROCESSES AND NOISE IN DRIVEN SYSTEMS.

W.Bernard and H.B.Callen.

Rev. mod. Phys., Vol. 31, No. 4, 1017-44 (Oct., 1959).

The interaction of an assembly with a number of external driving systems is treated as a perturbation problem, which is formally solved by an expansion in inverse powers of Planck's constant. The terms are transformed in various ways and the formal results are compared with those obtained by other workers. 16 references. The first order terms imply a relation between dissipation in the driven assembly and fluctuations in the unperturbed assembly, the fluctuation-dissipation theorem. Some physical applications of this are quoted, and a start is made on deriving analogous results for the higher order terms in the perturbation expansion. Questions such as the convergence or asymptotic correctness of such expansions are not discussed, but some passages to the classical limit are made.

H.N.V.Temperley

530.16 : 533.7

903 ON THE QUANTUM THEORY OF THE THIRD VIRIAL COEFFICIENT. A.Pais and G.E.Uhlenbeck.

Phys. Rev., Vol. 116, No. 2, 250-69 (Oct. 15, 1959).

The quantum theory of the third virial coefficient C is discussed. Three types of intermolecular pair forces must be distinguished. (1) No bound or low-lying two- and/or three-body states exist. The first four terms of the low-temperature expansion of C_{BE} are obtained. They depend on the scattering length, the effective range, and a third length which cannot be inferred from scattering data. The limitations of the applicability of such expansions are discussed, both for He^4 and He^3, by means of a comparison of the corresponding expansion for the second virial coefficient B with detailed numerical results known for specific potentials. (2) Existence of a near zero energy level both for the two- and the three-body system. It is shown how in this case the actual potentials may be replaced by suitably matched boundary conditions on the two- and the three-body wave-functions near the respective coordinate origins. It is first explained how the method applies to B. Then the leading term of C is explicitly determined. (3) Existence of strongly bound two- and three-body states. An approximate expression for C is given by treating the single atoms and the binary and ternary compounds as a system of three ideal gases in chemical equilibrium.

530.16

904 ON AN APPROXIMATE THEORY OF TRANSPORT IN DENSE MEDIA. S.A.Rice and J.G.Kirkwood.

J. chem. Phys., Vol.31, No.4, 901-8 (Oct., 1959).

A new approximate theory of transport is presented which starts from the general statistical mechanical theory of heat flux and the stress tensor and uses three principal approximations. These are (a) the expansion of the gradient of the pair interaction potential between molecules at time t + s about the gradient at time t and the neglect of all terms higher than the second, (b) the use of a local equilibrium distribution function in pair-space, and (c) the approximation of the pair diffusion tensor as the direct sum of singlet diffusion tensors. The intermolecular force contributions to the shear viscosity, bulk viscosity, and thermal conductivity are related to equilibrium properties of the fluid and, respectively, to other coefficients of the set of transport coefficients. Absolute calculations for liquid argon are within a factor of two of experiment. A semi-empirical calculation suggested by the theory and using the observed diffusion coefficient is in exact agreement with experiment. The validity of the three approximations is discussed.

530.16

905 THE RELATIVE RUNNING TIME OF A NON-STATIONARY CHANCE PROCESS. S.M.Rȳmov.

Radiotekhnika i Elektronika, Vol. 4, No. 9, 1415-18 (Sept., 1959). In Russian.

The ergodicity condition

$$\lim_{T\to\infty}\frac{1}{T^2}\int_0^T\int_0^T\psi_f(t,t')\,dt\,dt' = 0$$

where ψ (t, t') is the correlation function of f(X), is introduced for the process f[X(t)], where f is a determinate function and X(t) is a non-stationary chance process. On satisfying the above condition the relative running time of X(t) in the interval (x, x+dx) is given by the time-averaged unidimensional distribution function of process X(t). Two useful examples of averaged distribution are discussed.

D.E.Brown

530.19

906 THE DISAPPEARANCE OF THE ISOTHERMAL DISCONTINUITY AT GREAT DENSITIES OF RADIATION. V.A.Belokon'.

Zh. eksper. teor. Fiz., Vol. 36, No. 1, 341-3 (Jan., 1959). In Russian.

The discontinuity is shown to disappear in a sufficiently hot gas, by considering it as a continuous heat-conducting medium with local thermodynamic equilibrium. [English translation in Soviet Physics—JETP (New York), Vol. 36(a), No. 1, 235 (July, 1959)].

G.A.Chisnall

GENERAL MECHANICS

531.25 : 531.25

907 GELATIN AS A PHOTOELASTIC MATERIAL. H.G.Bayley.

Nature (London), Vol. 183, 1757-8 (June 20, 1959).

Gelatin—glycerin models containing about 20% gelatin may be stored satisfactorily in moist or in dry ambient air for at least 200 hr without any significant change in water content, Y, or stress-optical coefficient but the best method of storage is to replace the model in its mould using liquid paraffin as a lubricant. Time-edge effects develop in all stored models but they may be overcome by removing a thin layer from each loaded edge before testing. The addition of about 0.1% Na pentachlorphenate to the water when making up gelatin models prevents the growth of bacteria without altering the stress-optical coefficient. Mention is made of a method of overcoming the difficulties of preparing homogeneous gelatin—glycerin models; the observed stress-optical coefficient of models containing 20% gelatin and 12 or 14% glycerin was much higher than published values.

H.J.H.Starks

531.31

908 SIMPLE DERIVATION OF THE CLEBSCH—GORDAN COEFFICIENTS. R.T.Sharp.

Amer. J. Phys., Vol. 28, No. 2, 116-18 (Feb., 1960).

The three-dimensional angular momentum operator J takes a simple form when the operand is a scalar function $f(\xi,\eta)$ of the two complex variables ξ, η; so do the angular momentum eigenstates $f_m^j(\xi,\eta)$. Exploitation of this circumstance leads to a simple derivation of Racah's formula for the Clebsch—Gordan (vector addition) coefficients.

531.38

909 APPARATUS DRAWINGS PROJECT. REPORT NUMBER 3. AIR SUSPENSION GYROSCOPE. R.G.Marcley.

Amer. J. Phys., Vol. 28, No. 2, 150-5 (Feb., 1960).

The apparatus permits the quantitative study of gyroscopic precession. By suspending a rotating, magnetized, steel sphere on a jet of air and driving it as a synchronous motor by means of a rotating magnetic field, it is possible to eliminate, for all practical purposes, corrections for frictional losses in gimbal bearings. By using only a stop watch, micrometer caliper, and a simple stroboscope, an experimental error of 0.5% may be easily obtained. By suitable refinement of the equipment and techniques, an experimental error of 0.01% may be achieved.

531.53

910 HULA-HOOP: AN EXAMPLE OF HETEROPARAMETRIC EXCITATION. T.K.Caughey.

Amer. J. Phys., Vol. 28, No. 2, 104-9 (Feb., 1960).

This paper considers the parametric excitation of a pendulum swinging in a horizontal plane. It is shown that there exist a number of different limit cycle motions, one of which is a steady rotation about the point of support. This motion is associated with the mechanism whereby a hula-hoop may be kept in rotation by an oscillatory motion of the point of support. The stability and dependence of this type of motion on the initial conditions are analysed in detail.

531.55

911 OPTIMAL ACCURACY ROCKET TRAJECTORIES. G.A.Baker,Jr, K.W.Ford and C.E.Porter.

J. appl. Phys., Vol. 30, No. 12, 1925-32 (Dec., 1959).

The rocket optimization formulation of Fried (Abstr. 2116 of 1959) is modified slightly to facilitate the study of maximum accuracy trajectories. Various illustrative special solutions are obtained, particularly perturbation results valid for small thrust. For surface-to-surface rockets in a Kepler field, optimal thrust programmes are obtained numerically, their accuracy is studied quantitatively, and comparison of range and of accuracy is made with rockets using a constant-angle thrust programme. Optimization leads to only a slight increase in range but to a substantial gain in accuracy. The possible application of rocket optimization methods to the focusing of charged particles is also suggested.

531.55 : 534.22

912 DETERMINATION OF IMPACT POINT OF A VERTICALLY-FALLING BODY BY ACOUSTICAL OBSERVATIONS. G.V.Groves.

J. atmos. terrest. Phys., Vol. 11, No. 3-4, 284-8 (1957).

Simple formulae are obtained for calculating the coordinates of the impact point of a vertically-falling body from the arrival times of its shock wave at a number of microphones on the ground. The effects of wind and variations in the speed of sound are taken into account. When the microphones are closely spaced, the direction of the impact point can be found.

MECHANICAL MEASUREMENTS

531.78

913 A SENSITIVE TWO-LIQUID MICRO-MANOMETER.

A.Kogan.

Bull. Res. Coun. Israel, Vol. C7, No. 1, 33-6 (April, 1959).

The manometer consists of a U-tube built of tube segments of different diameters and filled with two immiscible liquids (kerosene and diluted ethyl alcohol). A small displacement of the free surfaces of the liquids by a pressure differential is accompanied by a much larger displacement of the interface. The theory given shows that it is best to use liquids of nearly equal densities.

S.Weintroub

531.78

914 A THERMISTOR HYPSOMETER.

W.R.Blackmore.

Canad. J. Phys., Vol. 37, No. 12, 1331-8 (Dec., 1959).

A thermistor hypsometer used as a sensitive, recording, gas-pressure measuring device is described. It is shown that the limitation on this device is the noise introduced by the pressure fluctuations over the surface of the boiling liquid. These fluctuations are about ± (5-10) μ Hg peak-to-peak. When a pressure measurement is averaged over a moderately short period of time it may be estimated to ± 1 μ Hg.

MECHANICS OF FLUIDS

(See also Magnetohydrodynamics)

532

915 FLUID MECHANICS.

L.D.Landau and E.M.Lifshitz. Translated from the Russian by J.B.Sykes and W.H.Reid.

London: Pergamon Press (1959) 536 pp. [Course of Theoretical Physics Vol. 6].

The subject is treated as a branch of theoretical physics. There are 17 chapters including accounts of: theory of heat transfer; acoustics; theory of combustion; dynamics of superfluids; and relativistic fluid dynamics. The authors point out in the preface that it has not been possible to include any new results which have appeared since the last Russian edition. There has however been the addition of a further chapter on the general theory of fluctuations on fluid dynamics.

532.1

916 FLOW OF AN ANOMALOUSLY VISCOUS SYSTEM UNDER THE ACTION OF TWO PURE SHEARS IN MUTUALLY PERPENDICULAR DIRECTIONS.

G.V.Vinogradov, A.A.Mamakov and V.P.Pavlov.

Dokl. Akad. Nauk SSSR, Vol. 127, No. 2, 362-5 (July 11, 1959). In Russian.

The non-Newtonian fluid studied was 86% spindle oil, 12% calcium soap of cotton-seed oil, and 2% water. Coaxial-cylinder viscometers, arranged to permit axial as well as circular flow, were used. The axial velocity gradient at the wall was computed from the axial volume flow rate, and the axial shear stress from the axial pressure drop. The dependence of velocity gradient on shear stress was measured both for pure axial and pure circular flow; the difference in the results for these two cases is attributed to a "memory" effect. The results for combined axial and circular flow are presented graphically, the most striking result being a negative dependence of axial stress on circular flow at constant axial flow. These results are explained on the hypothesis that the vector sum of the two velocity gradients depends on the vector sum of the stresses, in a way intermediate between those for pure axial and pure circular flow.

O.Penrose

532.5 : 536.7

CHANGE OF TOTAL ENTHALPY IN LAMINAR MOTION.

See Abstr. 221

532.5

917 DEMONSTRATION OF HYDRODYNAMIC FLOW.

R.E.Worley.

Amer. J. Phys., Vol. 28, No. 2, 165-6 (Feb., 1960).

532.5

918 STREAMLINES IN BÉNARD CONVECTION CELLS.

W.H.Reid and D.L.Harris.

Phys. of Fluids, Vol. 2, No. 6, 716-17 (Nov.-Dec., 1959).

The results of an earlier theoretical paper (Abstr. 2835 of 1958) are revised and extended. The streamlines corresponding to thermal instability of a viscous fluid contained between two rigid bounding surfaces and heated from below are calculated and plotted.

R.F.S.Hearmon

532.5

919 SYMMETRIC FLOW ABOUT A CIRCULAR CYLINDER WITH TWO VORTICES IN THE REAR. TRAJECTORIES OF THE VORTICES AND DRAG OF THE CYLINDER.

B.Dolapchiev and B.Sendov.

Dokl. Akad. Nauk SSSR, Vol. 128, No. 1, 53-6 (1959). In Russian.

Vortex flow of a perfect, non-viscous liquid is investigated by means of conventional mathematical methods. The results are shown in graphs and are discussed in connection with the results obtained by previous authors.

R.Eisenschitz

532.5

920 DYNAMIC INSTABILITY OF ACCELERATED FLUIDS.

C.T.Chang.

Phys. of Fluids, Vol. 2, No. 6, 656-63 (Nov.-Dec., 1959).

The asymmetrical growth of an interface separating two fluids of different densities, under the influence of an imposed acceleration (Rayleigh—Taylor instability), is shown to be mainly a nonlinear phenomenon. When the initial disturbance is a simple sinusoidal wave and is started from rest, it is found that the growth of the interface depends explicitly on two dimensionless parameters of the initial disturbance, namely, the dimensionless amplitude (i.e., the amplitude-to-wavelength ratio) and the dimensionless wave number (i.e., the wave number of the initial disturbance to the "cut-off" wave number of the medium under the prevailing experimental condition). Results of the analysis show that the asymmetrical development of the interface occurs much earlier for disturbances of larger amplitudes and lower wave numbers than those of smaller amplitudes and higher wave numbers, i.e., those with wave numbers near the "cut-off". Surface tension shows a definite stabilizing effect. Because of the nonlinear effect, for a sinusoidal initial disturbance, a generation of higher harmonics as well as a feed-back to the fundamental is noted. Contrary to the prediction of the linearized theory, the present analysis, based on higher order approximation, reveals an "over-stable" phenomenon for disturbances having initial wave numbers beyond the "cut-off".

532.5

921 SOME TRANSITION PATTERNS IN AXISYMMETRIC BOUNDARY LAYERS.

F.R.Hama.

Phys. of Fluids, Vol. 2, No. 6, 664-7 (Nov.-Dec., 1959).

Direct observation of the vortex pattern caused by a ring-shaped trip is made on 1 in. and $\frac{1}{2}$ in. circular cylinders and on a 30° cone in a water tank. Over the cylinders the boundary-layer thickness is approximately equal to the radius of the cylinders. Ring-shaped vortices are shed and deformed into vortex loops in the same manner as on a flat plate. On the cone the ring-shaped vortices are stretched and then inevitably deformed into vortex loops, indicating that a mere stretching is not a sufficient mechanism for the creation of a turbulence spot. A mechanism of the final breakdown from the vortex loop is tentatively proposed.

532.5

922 PLANE FREE OSCILLATIONS OF A PERFECT UNIFORM LIQUID IN AN INFINITE CANAL OF VARIABLE CROSS SECTION.

A.P.Legen'kov.

Izv. Akad. Nauk SSSR, Ser. geofiz., 1958, No. 8, 989-94. In Russian. English summary: PB 141042T-6, obtainable from Office of Technical Services, U.S. Dept. of Commerce, Washington, D.C., U.S.A.

The propagation of progressive waves in a canal is studied whereby it is assumed that the rectangular cross-section is uniform except for a finite segment where the depth or the breadth or both vary linearly with the distance from the beginning of the segment.

The equations of hydrodynamics are solved by standard methods. The solutions are discussed in terms of the transmission and reflection of waves by the variable segment. R.Eisenschitz

532.5

923 PROPAGATION OF TIDAL WAVES ON THE SURFACE OF A ROTATING LIQUID IN PRESENCE OF BOUNDARIES. S.S.Voit.

Dokl. Akad. Nauk SSSR, Vol. 127, No. 4, 764-7 (Aug. 1, 1959).
In Russian.

A rectangular basin is filled with a liquid and rotates about a vertical axis. A canal is connected to the basin at right angles to one of the walls. Equations of hydrodynamics are applied to the propagation of waves through the canal. R.Eisenschitz

532.5

924 DEVELOPMENT OF SURFACE WAVES GENERATED BY TRAVELLING VARIATIONS OF PRESSURE.

L.V.Cherkesov.
Dokl. Akad. Nauk SSSR, Vol 127, No. 4, 774-6 (Aug. 1, 1959).
In Russian.

Let an unbounded surface of a liquid at rest be exposed to periodic fluctuations of pressure; in particular, it is in the form of a progressive wave running along a strip of the surface. The resulting movement of the liquid is derived on the assumption that the flow is irrotational and is affected by gravitation but that surface tension and viscosity can be neglected. It is found that waves are formed which travel along and at right angles to the direction of the pressure waves. R.Eisenschitz

532.5

925 CONTRIBUTION TO THE THEORY OF ELASTIC VIBRATIONS OF A BODY CONTAINING LIQUID.

N.N.Moiseev.
Dokl. Akad. Nauk SSSR, Vol. 127, No. 1, 51-4 (July 1, 1959).
In Russian.

The hollow body is either partially or fully filled with a liquid. Using Hamilton's principle (variational integral) and appropriate Green's functions over the internal surface of the body and the free surface of the liquid, the author obtains integro-differential equations for the free motion of liquid surface. These equations are then transformed, for small amplitudes, to a Sturm-Liouville equation with a self-adjoint matrix operator. The eigenvalues of this operator can be found by the usual variational methods, which reduce the problem to a system of algebraic equations. J.K.Skwirzynski

532.5 : 530.16

926 STATISTICAL DYNAMICS OF TURBULENT [FLOW OF AN] INCOMPRESSIBLE LIQUID. B.I.Davŷdov.

Dokl. Akad. Nauk SSSR, Vol. 127, No. 4, 768-71 (Aug. 1, 1959).
In Russian.

By a procedure of averaging, the equations of motion of hydrodynamics are used for deriving relations between the mean pressure, mean velocity and mean power. This method is supposed to allow for the possible initial conditions, the exact specification of which cannot be controlled in experiments. In the course of the argument it is, however, necessary to make assumptions which could not be deduced from the hydrodynamical equations and can be verified only by eventual experimental test. It is found that the expression for the dissipation of energy in turbulence arises from non-dissipative terms in the equations of hydrodynamics. R.Eisenschitz

532.5

927 CONTRIBUTION TO THE STATISTICAL THEORY OF TURBULENCE. B.I.Davŷdov.

Dokl. Akad. Nauk SSSR, Vol.127, No. 5, 980-2 (Aug. 11, 1959).
In Russian.

For the purpose of specifying the turbulent flow in the boundary layer, relations are established between the statistical expectations of various hydrodynamical quantities, in particular of pressure, velocity, the space derivatives of velocity and their powers and the rate of dissipation. Some of these quantities can be derived from experiment but the available data are not sufficient for putting the theoretical relations to a test. R.Eisenschitz

532.5

928 PATTERNS IN TURBULENT FLOW IN THE WALL-ADJACENT REGION.

F.M.Richardson and K.O.Beatty.
Phys. of Fluids, Vol. 2, No. 6, 718-19 (Nov.-Dec., 1959).

A dilute solution of dye (or radioactive tracer) was followed by pure solvent in a turbulent stream in a circular tube, an abrupt transition being arranged by means of a bi-pass system. Visual, photographic and spectrophotometric observations indicate narrow longitudinal streaks of relatively high tracer concentration at intermittent positions along the tube, very near the wall, e.g. in water at Reynolds number 3800 in a 1 in. diameter glass tube. These are interpreted as eddies with an axis of rotation parallel to the tube axis, arising in what is usually considered to be the laminar sub-layer. J.G.Oldroyd

532.5 : 538.27

929 FLOW RATES USING NUCLEAR OR ELECTRON PARAMAGNETIC RESONANCE TECHNIQUES WITH APPLICATIONS TO BIOLOGICAL AND CHEMICAL PROCESSES.

J.R.Singer.
J. appl. Phys., Vol. 31, No. 1, 125-7 (Jan., 1960).

The equations for measuring flow rates are derived using n.m.r. and e.p.r. relaxation time determinations. Several experimental procedures are discussed. One method of measurement depends upon the difference between static relaxation times and the apparent relaxation time of materials flowing through the observation region. Another procedure utilizes saturated or inverted spins as a "tracer" to measure flow rates. These schemes may readily be applied to blood flow velocity measurements in humans or animals, or to mineral and chemical flow rate determinations. The advantage of this spin-resonance flowmeter is that the flow channel is not disturbed. Thus blood flow velocities are readily measured without the necessity of breaking the skin.

532.6

930 MECHANISM AND SPEED OF BREAKUP OF DROPS. G.D.Gordon.

J.appl. Phys., Vol.30, No.11, 1759-61 (Nov., 1959).

A mathematical analysis has been made of the breakup of liquid drops in an air stream; only the mechanism in which the drops flatten, become bowl-shaped, inflate like a parachute, and finally burst is considered. The analysis provides an understanding of this process of breakup and the conditions for which the viscosity and surface tension become important factors. An estimate of the breakup time for a wide range of conditions is obtained as a function of the drop diameter, surface tension, viscosity, drop density, air density, and velocity difference. The results are compared with the available experimental data.

532.6

931 SOME EXPERIMENTS ON THE DYNAMICS OF LIQUID FILMS. W.E.Ranz.

J. appl. Phys., Vol. 30, No. 12, 1950-5 (Dec., 1959).

Experiments and theory are described concerning the rupture of soap films and the continuous formation, by impinging jets, of quasi-stationary liquid sheets.

532.6

932 TAYLOR INSTABILITY AND THE DRIPPING OF LIQUIDS FROM HORIZONTAL SURFACES.

E.S.Rajagopal.
Curr. Sci., Vol. 28, No. 10, 392-3 (Oct., 1959).

The dripping of liquid from the wet underside of a horizontal plate is discussed, as an interface instability problem, on the assumption that there is a vertical axis of symmetry. The mode of disturbance that will increase most rapidly is calculated, and there is agreement with experiment, at least in order of magnitude. J.G.Oldroyd

LIQUID STATE

(Liquid helium is included under Low-Temperature Physics)

532.7

933 SOME PROPERTIES AND PROBLEMS OF THE LIQUID STATE. N.E.Cusack and J.E.Enderby.

Research, Vol. 12, No. 12, 475-81 (Dec., 1959).

The difficulties of obtaining accurate knowledge of the atomic distribution in liquids are pointed out. Three methods of studying liquid structure, by statistical mechanical theories assuming an interaction function, by direct geometrical methods and by using "cell theories" are described, and the electrical conductance of liquid metals is discussed.

532.7

934 MEASUREMENT OF THE EFFECT OF ELECTROSTRICTION IN SUNDRY LIQUIDS. V.A.Petukhov.

Akust. Zh., Vol. 4, No. 3, 286-8 (1958). In Russian.

The change in volume of the liquid under test, contained in a condenser tank, is measured by a mirror arrangement supported on the pillars carrying the two plates of the condenser, the said mirror forming part of an interferometer. Results of the measurements of electrostriction parameters are given for carbon tetrachloride, benzene and toluene [English translation in : Soviet Physics - Acoustics (New York), Vol. 4, No. 3, 294-6 (July-Sept., 1958)].

C.R.S.Manders

532.7

935 DIPOLE INTERACTIONS IN FLUIDS AND FLUID MIXTURES. J.S.Rowlinson.

Molecular Phys., Vol. 1, No. 4, 414-15 (Oct., 1958).

The method of averaging the interaction energy of two dipoles used by Balescu and by Prigogine is criticized by the author who indicates the correct way. It is pointed out that their conclusion (that most of the excess free energy of the chloroform/carbon tetrachloride mixture is due to dipole—dipole interaction) is wrong.

W.J.Orville-Thomas

532.7

936 INVESTIGATION OF THE DEPENDENCE UPON THE TEMPERATURE OF THE COEFFICIENT OF STRUCTURAL DIFFUSENESS. V.P.Tsvetkov.

Dokl. Akad. Nauk SSSR, Vol. 125, No. 6, 1235-7 (April 21, 1959). In Russian.

The coefficient of structural diffuseness is defined as a parameter in an analytical expression for the radial distribution function of a liquid. It depends upon the temperature and is supposed to vanish at the melting point. From the knowledge of this coefficient and its dependence upon the temperature the specific heat of the liquid can be derived by means of a theoretical formula. This formula is evaluated by means of experimental data concerning the distribution function of bismuth and tin. Comparison with the experimental specific heat of these liquid metals shows favourable agreement.

R.Eisenschitz

532.7

937 TIME-DEPENDENT PAIR CORRELATIONS IN LIQUID LEAD. B.N.Brockhouse and N.K.Pope.

Phys. Rev. Letters, Vol. 3, No. 6, 259-62 (Sept. 15, 1959).

Reports results of neutron scattering experiments on liquid lead in terms of the Van Hove correlation function $G(r,t)$ (Abstr. 8679 of 1954). It appears to be necessary to postulate large diffusion jumps, as well as the small atomic jitter, to account for the fact that the asymptotic diffusion rate given by $G(r,t)$ for large t is less than the rate of self-diffusion measured by tracers. The effect is similar to that found for water in Abstr. 3198 (1959).

J.Hawgood

532.7

938 FLUCTUATIONS AND THE LIMIT OF VALIDITY OF THE DEBYE—HÜCKEL THEORY.

H.S.Frank and P.T.Thompson.

J. chem. Phys., Vol. 31, No. 4, 1086-95 (Oct., 1959).

An equation derived by Fowler and by Kirkwood has the general form of the Poisson—Boltzmann equation of the Debye—Hückel theory (Abstr. 2328 of 1923) but shows the latter to fall short of rigorous correctness through omission of two terms proportional, respectively, to the part played by a cloud ion in inducing charge density and to the sum of the mean square fluctuations of the components of field strength. It seems likely that these correction terms would disappear or cancel for the case of an infinitely fine-grained ion cloud in a idealized continuous-dielectric solvent. By proceeding on this hint, it is shown that the equations of the Debye—Hückel theory contain within them the implication that ψ, ρ, E etc., are nonfluctuating and that the Debye—Hückel ion cloud does in fact approach infinite fine-grainedness in an appropriate sense as infinite dilution is approached. The theory, and the equations to which it leads, can thus be interpreted as being rigorously correct in the limit of infinite dilution but only in this limit. As concentration increases, failure of fine-grainedness begins to introduce errors into the equations and it is concluded that these become catastrophic and lead to a breakdown of the Debye—Hückel formalism at a concentration c_0, where the thickness of the ion cloud $1/k$, equals $\bar{l}$, an average distance apart of the nearest-neighbour ions. For 1-1 solutes in water at 25°C, $c_0 \cong 10^{-3}$ moles/1, and for higher valence-types, or lower dielectric constants, it is still smaller. These results may be paraphased by the statement that the Debye—Hückel theory is a theory of long-range interactions and fails when nearest-neighbour interactions begin to dominate. The suggestion emerges that for $\bar{c} > c_0$ the electrostatic behaviour of the ion cloud may be related to l as a characteristic length. This suggestion receives support from the observed fact that $\log f\pm$ seems typically to be linear in $c^{1/3}$ in the concentration range just above c_0.

532.7

939 ANISOTROPIC LIGHT SCATTERING OF STREAMING SUSPENSIONS AND SOLUTIONS. W.Heller.

Rev. mod. Phys., Vol.31, No.4, 1072-7 (Oct., 1959).

A review article concerned with three phenomena observed or expected if scattering occurs from suspensions and solutions when the scattering is observed subsequent to an orientation of the scattering bodies. These phenomena are dityndallism discovered by Diesselhorst and Freundlich (Abstrs. 671, 1090 of 1916) and investigated by Zocher [Kolloid Zeitschrift, Vol.37, 336 (1925)], conservative dichroism (Abstr. 775 of 1943) and bidissymmetry. The physical optics and theory of dityndallism are briefly discussed. Methods of measurement of conservative dichroism are given and its uses mentioned. These are (1) obtaining numerical data on dimensions of non spherical bodies, (2) getting information of changes in size, shape, and structure of aggregates formed during coagulation of anisometric particles as described by Heller (Abstr. 5168 of 1937) and (3) investigation of the mechanism and kinetics of sol-gel transformation. Brief theoretical details are given on bidissymmetry in unpolarized light (see Abstr. 4400 of 1958).

H.G.Jerrard

532.7 : 535.31

940 THEORY OF DEPOLARIZATION OF THE LIGHT DISPERSED BY SOLUTIONS OF MACROMOLECULAR SUBSTANCES. J.Moser.

Ann. Fac. Phil. Skopje, Sect. Sci. Nat., Vol. 10, 89-132 (1957). In Serbo-Croat.

The calculations are based on Kuhn's model [Kolloidzeitschrift, Vol. 68, 2(1934); Experientia, Vol. 1, 6(1945)] of macromolecules. The following properties and relationships are calculated: intensity of dispersed light transmitted by the analyser, function of intramolecular interference, and relation between the degrees of depolarization. Next the dispersion by solutions and single-component liquids is dealt with. Finally the possibility of determining the following magnitudes is described in detail: mean value of the square of the molecule length and molecular mass. 44 references.

F.Lachman

532.7 : 534.22

941 DISPERSION OF ULTRASONIC VELOCITY IN AQUEOUS SOLUTIONS OF ELECTROLYTES. B.Krishnamurty.

J. sci. industr. Res., Vol. 18B, No. 8, 346-7 (Aug., 1959).

The Debye—Hückel theory applied to the propagation in electrolytes suggests that a velocity maximum should occur when the ultrasonic frequency equals the reciprocal of the relaxation time of the ionic atmosphere.

H.D.Parbrook

532.7 : 535.33

942 RAMAN SPECTROGRAPHIC INVESTIGATION OF PYRIDINE IN DIFFERENT SOLVENTS.

J.Brandmüller and G.Glatzer.

Ann. Phys. (Leipzig), Folge 7, Vol. 4, No. 1-5, 229-33 (1959). In German.

An investigation of a possible analytical use of Raman spectroscopy based on the assumption that for every substance there are characteristic lines of high intensity which are the last to disappear when the material is diluted. The characteristic lines for pyridine and the limiting dilution in H_2O, CH_3OH, HCOOH, C_2H_5OH, dilute HCl and CCl_4 have been determined with a photoelectric recording Raman spectrometer.

R.C.Seymour

532.7 : 535.37

943 DETERMINATION OF THE QUANTUM YIELD OF LUMINESCENCE OF THE TRIVALENT TERBIUM ION IN SOLUTIONS. E.V.Kondrat'eva.

Optika i Spektrosk., Vol. 6, No. 3, 427-8 (March, 1959). In Russian.

Describes the yield determination for Tb^{+++} in aqueous solutions. The luminescence spectrum of Tb^{+++} consists of seven bands between 4000 and 7000 A and the quantum yield was found to be 0.8%. This means that the probability of radiationless transitions in Tb^{+++} in aqueous solutions is about two orders higher than the probability of radiative transitions.

A.Tybulewicz

532.7 : 535.37

944 DEPENDENCE OF THE PROBABILITY OF ENERGY TRANSFER IN SENSITIZED PHOSPHORESCENCE ON THE OSCILLATOR STRENGTH OF A TRIPLET-SINGLET TRANSITION IN THE MOLECULE OF AN ENERGY ACCEPTOR.
V.L.Ermolaev.
Optika i Spektrosk., Vol. 6, No. 5, 642-7 (May, 1959). In Russian.

In 1952 Terenin and the author discovered sensitized phosphorescence of aromatic compounds. Later it was found that a resonance transfer of energy with direct excitation of a triplet level in the energy acceptor takes place in sensitized phosphorescence. The present paper describes studies of the effect of the oscillator strength of triplet-singlet transitions in an energy acceptor on the probability of energy transfer and consequent quenching of phosphorescence of benzophenone and benzaldehyde. Phosphorescence of these two compounds was found to be quenched to the same extent by four acceptors (naphthalene, 1-chloronaphthalene, 1-bromonaphthalene and 1-iodonaphthalene) whose oscillator strengths differ by a factor of 100. This lack of influence of the oscillator strengths on quenching and other experimental facts contradict an assumption that energy is transferred to acceptors by an inductive interaction of molecular electromagnetic fields. A resonance mechanism of energy transfer is proposed instead. A.Tybulewicz

532.7 : 537.2

945 ON THE DIELECTRIC CONSTANT OF SOME AQUEOUS SOLUTIONS. A.Carrelli and L.Della Caggia.
Nuovo Cimento, Vol. 14, No. 1, 161-7 (Oct. 1, 1959).

Measurements of the dielectric constant of some aqueous solutions were made at a frequency of 8 Mc/s. After a description of the method and of the device used in the measurements, it is shown how it is possible to calculated the number of water dipoles blocked by each ion in solution, taking into account the variation of the dielectric constant.

532.7 : 537.2

946 ORIENTATIONAL POLARIZATION OF DIPOLAR GASES, SOLUTIONS AND LIQUIDS, TAKING ACCOUNT OF THE INNER FIELD. A.A.Borgardt.
Izv. Akad. Nauk SSSR, Ser. fiz., Vol. 22, No. 3, 268-73 (1958). In Russian. English summary: PB 141041T-3, obtainable from Office of Technical Services, U.S. Dept. of Commerce, Washington, D.C., U.S.A.

The influence of the internal field on the distribution of the inner field is unimportant, but elastic polarization of the molecules by the inner field must be considered. New formulae are developed which are consistent with experimental results. J.H.Mason

MECHANICS OF GASES

533.2

947 EXPRESSION OF HUMIDITY IN CENTIGRADE-GRAMMETRE SYSTEM. N.C.Mehra.
J. sci. industr. Res., Vol. 18B, No. 8, 347 (Aug., 1959).

533.6

948 SIMPLE WAVE FLOW IN DUCTS. R.Gundersen.
Phys. of Fluids, Vol. 2, No. 6, 680-7 (Nov.-Dec., 1959).

A centred simple wave is generated by the impulsive retraction of a piston. The sound speed perturbation and particle velocity perturbation are determined when the wave passes into a slowly diverging (or converging) section or a section which presents a throat. When the section of varying area terminates in a channel of constant cross-section, the result of passage through the transition section of varying area is the superposition of a perturbation which tends to decrease the flow velocity by a term which varies inversely with the time for a point moving with the wave, but increases linearly with the time at a fixed point in the channel, in agreement with results first presented by Chester with the use of a two-dimensional analysis. The flow of an arbitrary simple wave in the section of varying area is solved.

533.6

949 A STUDY OF AIR FLOW IN A LARGE-ION CHAMBER. G.A.Faucher.
J. atmos. terrest. Phys., Vol. 12, No. 4, 288-92 (1958).

Turbulence in a large-ion chamber has an influence on the measured ion mobility distribution. A technique was developed to investigate the flow in a large-ion chamber with titanium tetrachloride smoke. Many sources creating turbulence in the chamber were revealed. The entire set-up consisted of Pyrex glass, and the complete flow of smoke was recorded on cine film. These smoke experiments made it possible to re-design the chamber with laminar flow at air velocities up to 3 *l*./sec.

533.6

950 IMAGING OF GAS STREAMING WITH ELECTRON BURSTS. W.Schaaffs and M.Streich.
Z. angew. Phys., Vol. 11, No. 5, 188-90 (May, 1959). In German.

A burst of electrons lasting about 10^{-7} sec is used as a point source to form a shadow image of a moving gas stream. Photographs are shown of flow through nozzles and around obstacles.
A.E.I. Research Laboratory

533.6

951 A PROBE FOR THE MEASUREMENT OF DENSITY AND TEMPERATURE DURING SUPERSONIC MOTION IN A HIGHLY RARIFIED MEDIUM. G.A.Leikin.
Izv. Akad Nauk SSSR, Ser. geofiz., 1958, No. 4, 558-9. In Russian. English Summary : PB 141042T-5, obtainable from Office of Technical Services, U.S. Dept. of Commerce, Washington, D.C., U.S.A.

Theoretical paper with proposals for a simple probe consisting of a tube with long axis parallel to the direction of motion, an opening at the front end small compared to the molecular mean free path, and an energy detector within the tube. For a single-component, non-ionized gas, the molecular distribution across a tube section is a function of the thermal velocities, and the total flux entering the tube a function of the density of the medium and of the velocity of the body.
H.D.Parbrook

533.6

952 TURBULENT BOUNDARY LAYER MEASUREMENTS AT MACH NUMBERS FROM 8 TO 10. F.K.Hill.
Phys. of Fluids, Vol. 2, No. 6, 668-80 (Nov.-Dec., 1959).

Data are presented showing the properties of hypersonic boundary layers at Mach numbers from 8 to 10. The measurements extend experimental data on skin friction and heat transfer previously reported in the literature, and provide a basis for comparison with theory. Significant results of the investigation include the relatively rapid growth of the laminar sublayer at high Mach numbers, the increase in the momentum thickness with heat transfer, the decrease in the heat transfer coefficient, and the skin friction dependence on heat transfer and pressure gradient at high Mach numbers. The velocity profiles in the turbulent portion of the boundary layer are found to extend the trend evidenced at lower Mach numbers of a fit to a power profile, but with a somewhat lower velocity index ($n = 5$ as compared to 7 and 9 at lower supersonic Mach numbers). On the other hand an exponential fit to the experimental points provides equally good agreement, and satisfies better the physical conditions at the edge of the boundary layer.

GASEOUS STATE

533.7

953 A POSSIBLE SET OF [SIMULTANEOUS] EQUATIONS IN THE RELATIVISTIC DYNAMICS OF GASES, TAKING INTO ACCOUNT EMISSION AND ABSORPTION OF LIGHT. F.I.Frankl'.
Dokl. Akad. Nauk SSSR, Vol. 127, No. 5, 987-9 (Aug. 11, 1959). In Russian.

The movement of a material gas in presence of a photon gas is described by a set of simultaneous equations which are compatible with the principles of general relativity. Within the framework of this approach the temperatures of the two gases are different from each other. It is assumed that the rate of exchange of energy and momentum between matter and radiation is proportional to the differences of the 4-velocities of the two gases. In the non-relativistic limit and when applied to a gas at rest, this assumption results in the accepted relation between the energy flow and the intensity of radiation. R.Eisenschitz

533.7

954 GAS OF HARD NONATTRACTING SPHERES. O.K.Rice.
J. chem. Phys., Vol. 31, No. 4, 987-93 (Oct., 1959).

When a gas of hard nonattracting spheres is compressed it can go over into a densely packed random arrangement or a regular arrangement which becomes close packed at high densities. To these arrangements correspond two branches of the equation of state (pv/kT versus v). Though it is not possible to get an exact expression for the equation of state, the curves are fairly well determined by the application of certain general considerations concerning the entropy, by a general form for the random branch of the equation of state, and by some interpolations; certain geometrical factors having to do with the spherical shape of the particles are of some importance. Curves so obtained are compared with the results of some published machine calculations. The possibility of a first-order transition between the two branches is considered, and the position of such a transition, if it occurs, is roughly located.

533.7

955 THE FORCE OF AN NON-HOMOGENEOUS GAS ON SMALL SUSPENDED SPHERES. L.Waldmann.

Z. Naturforsch., Vol. 14a, No. 7, 589-99 (July, 1959). In German.

A gas, in which there is a gradient of temperature, exerts a force on suspended particles (aerosol). An expression for the force is derived on the assumption that the particles are small compared with the mean free path of the gas. For spherical particles the force does not depend on the accommodation coefficient. The calculation is extended to gas mixtures and a general expression for the force is considered and applied to the case of a diffusing mixture.

S.Weintroub

533.7

956 COLLISION INTEGRALS FOR THE EXPONENTIAL REPULSIVE POTENTIAL. L.Monchick.

Phys. of Fluids, Vol. 2, No. 6, 695-700 (Nov.-Dec., 1959).

The exponential potential function, $Ae^{-r/\rho}$, has long been regarded as the true qualitative form of the repulsive intermolecular potential at moderately small internuclear distances (or equivalently, high temperatures). Because of the increasing interest in gases at high temperatures it has become desirable to be able to evaluate the transport properties under these conditions. The calculation of integrals related to the usual collision integrals $\Omega^{(l\,s)}$ and cross-sections $Q^{(l)}$ have been carried out for the exponential repulsive potential. Some high-temperature viscosities have been calculated and compared to the calculated results of Amdur and Mason (see Abstr. 1168 of 1959) which are based on an experimental scattering potential.

533.7

957 TRANSPORT PROPERTIES OF HIGH-TEMPERATURE MULTICOMPONENT GAS MIXTURES.

E.A.Mason, J.T.Vanderslice and J.M.Yos.

Phys. of Fluids, Vol. 2, No. 6, 688-94 (Nov.-Dec., 1959).

An investigation is made of some modifications in the kinetic theory of gaseous transport properties which are necessary to take account of effects encountered at high temperatures. In particular, complications arise because of the existence of a multiplicity of different interaction energy curves governing collisions, and because of the possibility of resonant excitation and charge exchange during collisions. It is shown that the results of classical kinetic theory can be kept in the same form, but the cross-sections or collision integrals have to be computed differently. It is pointed out that the present modifications are valid to all orders of Chapman—Enskog approximation. It is also shown that excitation exchange is important in determining the transport properties of mixtures at high temperatures, and the method of calculation of the excitation exchange probability is extended to cases for which multiple interaction curves are involved.

533.7

958 HEAT FLOW BETWEEN PARALLEL PLATES.

E.P.Gross and S.Ziering.

Phys. of Fluids, Vol. 2, No. 6, 701-12 (Nov.-Dec., 1959).

A study is made of the flow of heat between parallel plates of slightly different temperatures. The problem is described by the linearized Boltzmann equation which is subject to microscopic boundary conditions. The distribution function is approximated by half-range polynomials in velocity space and determine the space-dependent coefficients by forming half-range moment equations. An approximation involving four pairs of space functions suffices to give an accurate treatment of the heat flow and of the density and temperature profiles for the entire range of conditions from free molecule to hydrodynamic. Detailed numerical results for the temperature slip and molecular boundary structure are obtained for hard-sphere molecules. The accuracy of cruder half-range approximations and other methods of fixing the coefficients is established.

533.7

959 THERMAL DIFFUSION IN GASEOUS MIXTURES.

El.Nadi and N.Farag.

J. Chim. phys., Vol. 56, No. 7, 631-5 (July, 1959). In French.

The measurement of the thermal diffusion coefficients at temperatures between 300° and 480°K for various mixtures of the gases (H_2—CO_2, H_2—SO_2 and H_2—C_2H_5Cl) is described. The apparatus is described and illustrated and the results are shown graphically and tabulated.

S.Weintroub

533.7

960 THE REAL EFFECT OF THERMAL EFFUSION.

W.Kleinpaul.

Z. Elektrochem., Vol. 62, No. 8, 877-81 (1958). In German.

Where the mean free path of the gas molecules is of the same order as the diameter of the connection between two reservoirs which are maintained at different temperatures, thermal effusion is controlled by the relative pressure difference in the two vessels as well as their different temperatures.

R.Schnurmann

533.7

961 THE SEPARATION OF RADIOACTIVE XENON FROM HYDROGEN AND DEUTERIUM BY MEANS OF THERMAL DIFFUSION. D.Heymann.

Z. Naturforsch., Vol. 14a, No. 7, 603-9 (July, 1959). In German.

In suspension reactors the fission products escape continuously from the fuel material into the moderator fluid as well as in the gas phase. Radio-xenon and radio-krypton may be removed in principle by absorption or by radioactive decay; however the thermal diffusion method promises some advantage. The thermal diffusion factor of Xe in H_2 and D_2 has been measured in the temperature range 300-700°K (~ 0.55 at 300°K → 0.85 at 700°K). Xe^{133} served as a tracer gas for the determination of the concentration. A hot wire column (tube radius 1.3 cm, wire radius 0.02 cm) was used and the optimum pressure was about 1 atm. The dependence of the separation factor, initial transport and relaxation time of the column on pressure and the average gas temperature was determined and satisfactory agreement with theory obtained. It is estimated that using a double tube column of ~ 5 cm radius and 50 cm length at a pressure of 40 atm it should be possible to purify about 3.7 litres (n.t.p.) per hour. In the pure gas the xenon concentration would be ~ 10 times smaller than in the feed gas.

H.C.Cole

533.7

962 EQUATION OF STATE AND THERMODYNAMIC PROPERTIES OF GASES AT HIGH TEMPERATURES. I. DIATOMIC MOLECULES. O.Sinanoğlu and K.S.Pitzer.

J. chem. Phys., Vol. 31, No. 4, 960-7 (Oct., 1959).

Methods for evaluating the thermodynamic properties of assemblies of chemically reacting unionized atoms are discussed. The desirability of using the virial coefficients at high temperatures instead of the customary use of the molecular partition functions with anharmonicity corrections is emphasized. The most realistic three-parameter diatomic potential energy function that is available at present, i.e., the Rydberg potential, $U/U_e = -(1 + b'\xi)\exp(-b'\xi)$ with $\xi = (r/r_e) - 1$ is selected for the evaluation of the classical second virial coefficient. $B(T)$, $T(dB/dT)$ and $T^2(d^2B/dT^2)$ are obtained as linear combinations involving the five functions:

$$A_k(\theta) = \sum_{n=1}^{\infty} [(\theta e)^n/n^{n+k}],$$

$[k = -1, 0, 1, 2, \text{ and } 3, \text{ and } \theta = (U_e/kT)]$ with only the coefficients that multiply A_k depending on b'. A_k is tabulated for $0.05 \leq \theta \leq 10$. A simple expression for estimating the quantum correction to B(T) is given. The inclusion of the contribution of the higher diatomic electronic states to B(T) is considered. The treatment is applied to sodium (including the $^3\Sigma$ repulsive state), and B(T) and thermodynamic properties calculated at two temperatures by several methods are compared.

533.7

963 THERMODYNAMIC FUNCTIONS OF SOME GASEOUS DIATOMIC HALIDES OF ALUMINUM, BORON, AND LITHIUM. R.L.Altman.

J. chem. Phys., Vol. 31, No. 4, 1035-8 (Oct., 1959).

A literature survey was made to locate spectroscopic data on the gaseous halides of Al, B and Li. The thermodynamic functions were computed and a tabulation of the heat capacity, enthalpy, and entropy of the gaseous diatomic bromides, chlorides, and fluorides of Al, B and Li was made from 0° to 6000°K.

533.7

964 THERMODYNAMIC FUNCTIONS OF SOME CHLORINE COMPOUNDS. R.L.Potter.

chem. Phys., Vol. 31, No. 4, 1100-3 (Oct., 1959).

The thermodynamic functions of Cl(g), Cl_2(g), HCl(g), and F(g) were calculated for these substances in the ideal gas state rom 273.15° to 5000°K by standard methods of statistical mechanics sing available spectroscopic data.

533.7 : 530.16

QUANTUM THEORY OF THE THIRD VIRIAL COEFFICIENT.

ee Abstr. 903

533.7

965 THERMODYNAMIC STUDY OF InSb WITH A MASS SPECTROMETER.

DeMaria, J.Drowart and M.G.Inghram.

chem. Phys., Vol. 31, No. 4, 1076-81 (Oct., 1959).

The gaseous molecules in thermodynamic equilibrium with olutions of indium and antimony were determined and their partial ressures measured. From these measurements, partial molar free nergies, and heats and entropies of solution were calculated. In ddition, for the gaseous molecules the following dissociation energies (in kcal/mole) were obtained: ΔH_0° (Sb—Sb) = 70.6 ± 1.5; H_0° (In—In) = 22.4 ± 2.5; ΔH_0° (In—Sb) = 35.4 ± 2.5; ΔH_0° (InSb—Sb) = 6.7 ± 2.5.

533.7

966 FOURTH VIRIAL COEFFICIENT FOR THE SQUARE WELL POTENTIAL. S.Katsura.

hys. Rev., Vol. 115, No. 6, 1417-26 (Sept. 15, 1959).

The fourth virial coefficient D and its components D_1, D_2, D_3 for olecules interacting with a square-well potential have been obtained functions of the temperature by the use of Fourier transformation nd the addition theorem of Bessel functions. Each component and eir sum are nearly constant above the Boyle temperature and tend negative infinity as the temperature tends to zero. The total is expressed by

$$D/b^3 = 0.286\,42 + 1.539\,7f - 23.554f^2 + 53.645f^3 + \\ + 69.859f^4 - 170.01f^5 - 14.777f^6,$$

here $f = e^{\epsilon/kT} - 1$, and well width is equal to the hard core diaeter. Corrections of the critical data and some related problems e discussed.

533.7 : 535.3 : 534.23

967 THE OPTIC-ACOUSTIC EFFECT IN GASES. M.E.Delany.

i. Progr., Vol. 47, 459-67 (July, 1959).

Review. When radiation-absorbing gases and vapours are posed to periodically interrupted thermal radiation, a corresponng heating and cooling of the gas occurs, producing pressure uctuations and thus emission of sound. This is the Tyndall-Röntgen optic-acoustic effect. Recent experimental and theoretical investations involving the application of the effect to gas analysis and its se for the determination of intermolecular collision efficiencies, e briefly reviewed. (24 refs.) S.Weintroub

533.7 : 535.3 : 534.23

968 ON THE THEORY OF THE OPTICO-ACOUSTIC GAS ANALYSER. A.O.Sall'

h. tekh. Fiz., Vol. 29, No. 3, 330-43 (March, 1959). In Russian.

The optico-acoustic analyser consists of a chamber filled with e gas to be studied and a monochromatic light source whose wavength can be varied. The light beam is interrupted by a rotating sk with apertures. Pulses of light are absorbed by the gas produng pressure pulses by heating. These pressure pulses are picked by a microphone and their amplitude is recorded. Wavelength of e incident beam is varied and the recorded pressure-pulse amplide is found to be proportional to optical absorption of the gas. In is way the absorption spectrum can be obtained. The present paper escribes methods of improving the accuracy of measurements with optico-acoustic gas analyser by suitable selection of the dimenons of the gas chamber and other working parameters.

A.Tybulewicz

533.7 : 535.3 : 534.23

969 ON THE SENSITIVITY THRESHOLD OF AN OPTIC-ACOUSTIC RECEIVER OF RADIATION. I. LOW DULATION FREQUENCY. A.O.Sall'.

tika i Spektrosk., Vol. 6, No. 2, 219-25 (Feb., 1959). In Russian.

A selective optico-acoustic receiver (Veingerov's spectrophone) rks by excitation of acoustic vibrations in a closed vessel. Such a vessel is filled with gas and the vibrations are excited by absorption of light from a light beam which is interrupted by means of a rotating disk with apertures. Sensitivity of an optico-acoustic receiver is limited by thermal fluctuation noises in the gas, by electrical fluctuations in the microphone used to detect acoustic vibrations and in the input stage of an amplifier, as well as by external vibrations. Results of a theoretical investigation of the threshold sensitivity of optico-acoustic receivers and non-selective receivers using an absorbing film are given in the present paper. Formulae are obtained for determination of the numerical value of the sensitivity threshold which are valid at low frequencies of interruption of the light beam. A.Tybulewicz

533.7 : 535.3 : 534.23

970 ON THE SENSITIVITY THRESHOLD OF AN OPTICO-ACOUSTIC RECEIVER OF RADIATION. II. A NON-UNIFORM LIBERATION OF HEAT IN THE SELECTIVE-RECEIVER CHAMBER. HIGH-FREQUENCY MODULATION. A.O.Sall'.

Optika i Spektrosk., Vol. 6, No. 4, 556-61 (April, 1959). In Russian.

For Pt I see preceeding abstract. The paper deals with the case of a non-uniform distribution of thermal radiation in the chamber of a selective optico-acoustic receiver. Formulae are obtained for numerical values of the sensitivity threshold of selective and non-selective receivers, which are valid at high-frequencies of modulation. Formulae are also given for the optimum length of the selective-receiver chamber (cylindrical in shape) and for the optimum concentration of the absorbing gas. A.Tybulewicz

533.7 : 535.3 : 534.23

971 ON THE SENSITIVITY THRESHOLD OF AN INFRARED ABSORPTION GAS ANALYSER WITH GAS MODULATION. A.O.Sall'.

Optika i Spektrosk., Vol. 6, No. 3, 394-7 (March, 1959). In Russian.

Deals with infrared absorption gas analysers which use optico-acoustic receivers (see all preceding abstracts). Sensitivity of two-beam analysers is limited by random variations in the beams; these variations affect the zero point of the analyser. The author describes a new one-beam analyser with gas modulation. In this analyser the number of molecules of the component to be determined is varied periodically in the working chamber, leaving the amounts of the other components unchanged. Such a variation may be achieved, say, by chemical absorption. The threshold sensitivity of this analyser coupled with a selective and a non-selective optico-acoustic receiver is discussed. It is found that the sensitivity is slightly higher when a non-selective receiver is used. A.Tybulewicz

533.7 : 535.33

972 EXPERIMENTAL STUDY OF THE INFRARED ABSORPTION SPECTRA OF SOME COMPRESSED GASES AND GASEOUS MIXTURES. R.Coulon.

J. Rech. Cent. Nat. Rech. Sci., No. 45, 305-37 (Dec., 1958). In French.

The gas handling apparatus and the cells for containing the gases are described in detail; pressures up to 6 000 atmospheres and path lengths up to 3.5 m may be used. A Perkin Elmer spectrometer is modified to take the long cells, a Zr arc and cooled PbTe cell. Pressure induced vibrational bands are observed for O_2, N_2, CH_4 and H_2; the H_2 band shows some rotational structure. The induced absorption in H_2 is increased by addition of HCl and is shifted by addition of N_2O. When HBr, HCl and HF are compressed with various gases the vibration-rotation bands are modified, in some cases a Q-branch appearing. With mixtures $HCl-H_2$, $HBr-H_2$, N_2-H_2 and N_2O-H_2 intermolecular combination bands are observed. Calculations of the interaction between polar and non-polar molecules, using a simple electrostatic model, give reasonably good approximations to the intensities of the bands. Other similar work is reviewed and there are 86 references. G.F.Lothian

533.7

973 SPECTROSCOPIC STUDIES OF THE STATE OF GAS BEHIND A SHOCK WAVE. I.

N.N.Sobolev, A.V.Potapov, V.F.Kitaeva, F.S.Faizullov, V.N.Alyamovskii, E.T.Antropov and I.L.Isaev.

Optika i Spektrosk., Vol. 6, No. 3, 284-96 (March, 1959). In Russian.

The paper describes attempts to measure the temperature behind a shock wave using relative intensities of two spectral lines. Shock waves of 3-4 km/sec velocities were produced in a shock tube. At these velocities the temperatures behind shock fronts were expected to be 3500-4500°K. It was found that the method of relative intensities was unsuitable for determination of temperatures below 5000°K. A.Tybulewicz

533.7 : 535.33 : 532.7

974 CONTRIBUTIONS TO THE INTERPRETATION OF INFRARED ABSORPTION SPECTRA OF LIQUID MIXTURES AND COMPRESSED GASES. L.Galatry.
J. Rech. Cent. Nat. Rech. Sci., No. 46, 43-88 (March, 1959).
In French.

The author deals firstly with the vibration spectra of dissolved substances in the liquid state, and more particularly with any frequency shifts seen in the transitions from gas to solution. The frequency displacements are calculated using a modification of the "point-dipole" interaction theory of Kirkwood, Bauer, and Magat, and agree well with experimental values for solutions of HCl. The second part is devoted to a study of compressed gaseous mixtures containing a polar constituent. The various types of absorption bands found are treated by analysing the dipole moment of a pair of molecules. A further calculation involving a simplified quantum treatment gives information about the band profiles, and substantiates experimental results obtained with $CO-N_2$ and $HCl-N_2$ mixtures. D.L.Greenaway

533.7 : 537.52

975 DECOMPOSITION OF n-BUTANE IN AN ELECTRIC DISCHARGE.
A.Kuppermann and M.Burton.
Radiation Research, Vol. 10, No. 6, 636-54 (June, 1959).

The effects of an electric discharge (believed to be of the glow type, and to have a temperature below 100° C) on $n\text{-}C_4H_{10}$ and on its mixtures with $n\text{-}C_4D_{10}$, D_2 and A have been studied. The products formed in pure $n\text{-}C_4H_{10}$ were compared with those from $i\text{-}C_4H_{10}$, and with those produced by irradiation with 1.5 MeV electrons. In pure $n\text{-}C_4H_{10}$ the rate of disappearance was first order in $n\text{-}C_4H_{10}$ and order $\frac{1}{2}$ to 1 in current. The main gaseous products were H_2, C_2H_2, C_2H_4 and CH_4. The average efficiency of conversion of electrical to chemical energy in these experiments was about 50%. It is concluded that ionic reactions, and molecular detachment of CH_4 from $n\text{-}C_4H_{10}$, are not important, and that the mechanism is one involving energy transfer from electrons in the discharge to radicals via excitations of low-lying electronic states in the radicals.
C.B.Allsopp

VACUUM PHYSICS

533.5

976 DESIGN OF GLASS OIL - VAPOUR VACUUM PUMPS.
N.A.Florescu.
Lab. Pract., Vol. 9, No. 1, 33-4 (Jan., 1960).

The experimental result that a lower pressure is obtained when the choke tube of an ejector jet is not cooled was embodied in the design of an oil-vapour pump. The operating characteristics as well as the performance of a three stage pump made of glass are given.

533.5

977 THE PERFORMANCE AND DESIGN OF A TITANIUM GETTER PUMP OF HIGH PUMPING SPEED.
L.Holland and L.Laurenson.
Vide, Vol. 14, 141-50 (May-June, 1959). In French and English.

A Ti getter pump using a source in which a Ti wire is fed down through a cooled Cu block is described. With this source a large globule of Ti can be held at a temperature high enough to evaporate 40 mg/min. For nitrogen, a speed of 800 l./sec is obtained at 10^{-6} torr. When a diffusion pump is added the speed increases to 1750 l./sec. Owing to the argon content, air is pumped much more slowly. A.H.W.Beck

533.5

978 THE MEASUREMENT OF THE PUMPING SPEED OF A VACUUM PUMP. A.Venema.
Vide, Vol. 14, 113-20, (May - June, 1959). In French and English.

The author points out that in measuring the speed of a diffusion pump care must be taken in measuring the pressure at the throat of the pump since this quantity varies with the direction of measurement. To avoid this difficulty a dome may be fitted over the pump and the pressure in the dome used in calculations. Experiment shows that the diameter of the dome must be at least three times greater than that of the pump if an accurate measurement of speed is required. T.Mulvey

533.5

979 OUTGASSING CAUSED BY ELECTRON BOMBARDMENT OF GLASS. B.J.Todd, J.L.Lineweaver and J.T.Kerr.
J. appl. Phys., Vol. 31, No. 1, 51-5 (Jan., 1960).

A flow system used for continuous measurement of the gases evolved from aluminized glass during bombardment with 20 keV electrons is described. The system is also suitable for gettering measurements. A cathode-ray tube containing the samples is sealed directly to the source of a mass spectrometer. Calibration of the first flow system built revealed the gettering of oxygen by the graphite-silicate conductive coating and the hot metal parts of the electron gun of the cathode-ray tube. This gettering was minimized in a second flow system. It was found that oxygen constitutes at least 95% of the gas evolved from each of five types of glasses investigated. Also, a graphite-silicate coating can play a dual role in a cathode-ray tube; when not bombarded by electrons it is an active getter for oxygen, but when bombarded it is a source of oxygen, carbon monoxide, and carbon dioxide.

533.5

980 THE MAGNETRON GAUGE : A COLD-CATHODE VACUUM GAUGE. P.A.Redhead.
Canad. J. Phys., Vol.37, No.11, 1260-71 (Nov., 1959).

A cold-cathode ionization gauge with axial magnetic field is described which is capable of measuring pressure in the range 10^{-3} to 10^{-12} mm Hg, and is primarily useful in the range above 5×10^{-10} mm Hg. The gauge is operated with an anode voltage of 6 kV and a magnetic field of 1000 G. The relationship between ion current and pressure is linear in the pressure range 10^{-4} 5×10^{-10} 5×10^{-10} mm Hg; at lower pressure the relationship $i_+ = cP^{1.7}$ obtains. In the linear region the ion current per unit pressure is given by i_+ (amperes) $\cong$ 9P (mm Hg) for nitrogen (i.e. a sensitivity about 45 times greater than obtainable with a thermionic triode gauge).

533.5 : 621.385.1

981 ALL-METAL BAKEABLE TAPS FOR HIGH VACUUM.
N.W.Robinson.
Electronic Engng, Vol. 31, 759-60 (Dec., 1959).

In an increasing number of microwave and image intensifier tubes it is becoming necessary to create vacuums of the order of 10^{-10} mm Hg. This may be accomplished by a system described by Alpert (Abstr. 8274 of 1953): in this system a greaseless isolating tap is a necessary component. In this article a suitable all-metal bakeable tap is described and its performance enumerated.

VIBRATIONS · ACOUSTICS

534.1 : 621.389

982 SPACE REQUIREMENTS FOR SIMPLE MECHANICAL SYSTEMS EXCITED BY RANDOM VIBRATION.
H.Himelblau and L.M.Keer.
J. Acoust. Soc. Amer., Vol. 32, No. 1, 76-80 (Jan., 1960).

The problem of collision between a simple mechanical oscillator (with damping) and an adjacent rigid member, or between two adjacent simple oscillators, when both are subjected to random vibration is solved in terms of probability of occurrence and the mean time between occurrences. A complete solution is obtained for white Gaussian excitation. This solution can be applied to such problems as the mechanical design of electronic components, bottoming of resilient mounts, and collision between an equipment item and adjacent structure, when the representations of a single degree-of-freedom system can be used.

534.12

983 THE VIBRATION OF PLATES.
I.Malecki and S.Kaliski.
Hochfrequenztech. u. ElektAkust., Vol. 67, No. 4-5, 120-4 (Jan., 1959). In German.

The investigation describes: (1) the mechanical properties of plates (assumed thin compared with the wavelength); (2) the boundary effects due to the method of fixing the plate; and (3) the mechanism of energy transmission through the plate, for impact. The theoretical deductions are supported by experimental observations of the frequency spectra of the transmitted sound. An example is given of hard impact, a steel hammer striking a single-layer ceiling. The results have application to sound propagation in buildings. A.B.Wood

534.13

984 FORCED VIBRATIONS OF THE SYSTEM WITH TWO DEGREES OF FREEDOM WITH COULOMB DAMPING.

Y.Sawaragi, T.Fujii and Y.Okada.

Bull. Japan Soc. Mech. Engrs, Vol. 2, No. 6, 311-17 (May, 1959).

An analytical solution of the problem of a system comprising two spring-suspended masses with constant friction between the masses or between the lower mass and the supporting base is obtained for the case of a harmonic disturbing dispacement. These systems are encountered in the vibrations of railway vehicles. At resonance, there is a critical value of the friction; below this value, the amplitude of the masses becomes infinitely large whilst above it there is a motion with stops or without relative displacement of the masses. A motion with stops occurs at 1/3, 1/5, 1/7 ... of the natural frequencies. At a very high frequency, a motion with stops or without relative displacement of the masses occurs if the friction between the masses is larger than a certain critical value but no stop motion occurs whatever the friction between the mass and the supporting base. A few experiments showing close agreement with the theoretical results are described. H.J.H.Starks

534.13

985 RESONANCE INVESTIGATIONS WITH UNBALANCED EXCITATION. F.Weidenhammer.

Frequenz, Vol. 13, No. 5, 133-42 (May, 1959). In German.

This paper presents a theoretical study of the behaviour of a system comprising a spring-mounted mass with damping proportional to velocity when excited by a pair of oscillatory masses. Special attention is paid to the performance of the system near the resonance point and to the factors affecting stability. H.J.H.Starks

534.2

986 ON BOUNDARY CONDITIONS FOR JUMPS IN DISCONTINUOUS SOLUTIONS OF THE DYNAMICAL EQUATIONS OF ELASTICITY THEORY.

G.A.Skuridin and A.A.Gvozdev.

Izv. Akad. Nauk SSSR, Ser. geofiz., 1958, No. 2, 145-56. In Russian. English Summary : PB 141042T-1, obtainable from Office of Technical Services, U.S. Dept. of Commerce, Washington, D.C., U.S.A.

These boundary conditions are established for the reflection and the refraction of elastic waves (including the case of shock waves) on general curvilinear boundaries, which are within the limits of "the principle of the isolated element". The resultant boundary conditions are exact for discontinuous solutions and asymptotic for continuous ones; in this last case they are expanded in inverse powers of frequency (in the regions of high frequencies). The fundamental equations of motion in an inhomogeneous elastic medium are first suitably transformed and solved; next, the cases of reflection of elastic waves from fixed and from free boundaries of a half-space are discussed. J.K.Skwirzynski

534.2 : 517.9

SOLUTION OF THE DAMPED WAVE EQUATION.

See Abstr. 822

534.2 : 550.34

987 THE EFFECTIVE DYNAMICAL PARAMETERS OF INHOMOGENEOUS ELASTIC MEDIA DURING THE PROPAGATION OF PLANE LONGITUDINAL WAVES.

I.M.Khaikovich and L.A.Khalfin.

Izv. Akad. Nauk SSSR, Ser. geofiz., 1959, No. 4, 505-15. In Russian.

The authors consider the problem of effective dynamical parameters of inhomogeneous media during the propagation of seismic signals. The mathematical analysis is conducted on the basis of a two-dimensional model medium consisting of two regions with different properties and subjected to a longitudinal, plane wave. The general relations, thus obtained between effective parameters, show that the inhomogeneous medium is absorptive and dispersive. The theory developed follows usual techniques used in formulating properties of "loaded" dielectrics. J.K.Skwirzynski

534.21

988 THE EFFECTIVE DYNAMIC PARAMETERS OF NON-UNIFORM MEDIA DURING PROPAGATION OF SOUND WAVES. I.M.Khaikovich and L.A.Khalfin.

Akust. Zh., Vol. 4, No. 3, 275-81 (1958). In Russian.

A theoretical paper, considering a uniform medium consisting of a rectangular lattice with irregularities distributed through it, and the effect of these latter upon the dynamic parameters relating to wave propagation. Formulae are obtained for calculating "effective" parameters for a non-uniform medium. It is shown that irregularities give rise to dispersion and absorption. [English translation in: Soviet Physics—Acoustics (New York), Vol. 4, No. 3, 280-6 (July-Sept., 1958)]. C.R.S.Manders

534.22

989 FORMULAS FOR THE COMPUTATION OF SOUND SPEED IN SEA WATER. K.V.Mackenzie.

J. Acoust. Soc. Amer., Vol. 32, No. 1, 100-4 (Jan., 1960).

Equations are presented for the computation of sound speed that are designed to agree with Kuwahara's tables. These are in general use for the mass reduction of oceanographic data. The equations give the temperature, salinity, depth, and latitude dependence and the interaction effects due to the simultaneous variation of temperature, salinity, and depth. Some in situ measurements utilizing the bathyscaph are presented.

534.22

990 DISPERSION OF HIGH FREQUENCY DILATATIONAL WAVES IN SOLIDS. A.Zarembovitch.

C.R. Acad. Sci. (Paris), Vol. 248, No. 19, 2716-18 (May 11, 1959). In French.

The velocity of waves propagated between the two plane faces of a solid for different values of wavelength and thickness was measured by exciting vibrations in glass specimens of different size and observing when resonance occurred, as indicated by a crossed polarizer technique. Differences in velocity of the order of 3×10^{-4} were detectable and measurements were made in the range 3-15 Mc/s. The results fitted the expression

$$\frac{\Delta V}{V_\infty} = \frac{V_\infty^2.\gamma^2}{8\pi^2.f^2}$$

where $\Delta V = V - V_\infty$, V_∞ = velocity of propagation in the solid (infinite extent), V = velocity of propagation of dilatational waves in the solid (finite size), f = resonant frequency and γ = a coefficient which defines the influence of the limited size of the specimen; its exact value is not known but it is real, positive and decreases with f. H.J.H.Starks

534.22

991 CONTRIBUTION TO THE THEORY OF SHOCK WAVES. G.Ya.Galin.

Dokl. Akad. Nauk. SSSR, Vol. 127, No. 1, 55-7 (July 1, 1959). In Russian.

The author regards shock waves as discontinuous limits of continuous wave-functions. Existence theorems for these functions are derived from the equations determining the propagation of a wave front. R.Eisenschitz

534.22

992 ON THE BALLISTIC WAVES GENERATED BY SUPERSONIC AEROPLANES IN LEVEL FLIGHT. P.Dassault.

C.R. Acad. Sci. (Paris), Vol. 249, No. 2, 212-15 (July 15, 1959). In French.

Discusses the variation of intensity of the conical shock wave from a supersonic plane, in level flight, where it intersects the ground in a hyperbolic curve. L denotes the length of trajectory of a shock issuing from the plane to its point of arrival on the ground, with an intensity sufficiently reduced to become practically negligible. If L is the length for speed Mach 3, then it is shown that the corresponding lengths for speeds Mach 2, 1.4, 1.2 and 1.1 are 0.85 L, 0.7 L, 0.55 L and 0.40 L respectively. If a value of 20 km is adopted for L it is found that the altitude for "silence on the ground" varies between 8 km for Mach 1.1 and 20 km for Mach 3. The author refers to the function L as the power of propagation of the ballistic wave. A.B.Wood

534.22 : 539.3

993 A SHOCK WAVE IN A PLASTIC MEDIUM WITH VARIABLE DENSITY.

E.I.Andriankin and V.I.Koryavov.

Dokl. Akad. Nauk SSSR, Vol. 128, No. 2, 257-60 (Sept. 11, 1959). In Russian.

A mainly theoretical treatment of a spherically-symmetric shock wave expanding into a plastic medium. In front of the shock the density and pressure are constant. Across the shock the density changes by an amount depending on the pressure change, and behind the shock the density at any particle remains constant. The equations of motion and shock relations are solved under certain simplifying assumptions and the results are presented graphically and compared with experiment. O.Penrose

534.22 : 541.12

994 INVESTIGATION OF THE TRAIL IN SPINNING DETONATIONS. R.I.Soloukhin and M.E.Topchiyan.
Dokl. Akad. Nauk SSSR, Vol. 127, No. 4, 772-3 (Aug. 1, 1959).
In Russian.

A mixture of oxygen and carbon monoxide is exploded in a tube under such conditions that the detonation front is followed by a luminescent trail moving along a helical path near the inner wall of the tube. The tangential velocity of the trail is measured by a stroboscopic method and found to be 1735 m/sec whereas the velocity of sound in the gas in only 942 m/sec. It is found that these results fit an appropriate solution of the wave equation of acoustics.
R.Eisenschitz

534.23

995 THE PROPAGATION OF ULTRASONIC FINITE AMPLITUDE WAVES IN A RELAXING LIQUID.
V.A.Krasil'nikov and D.V.Khatinov.
Akust. Zh., Vol. 5, No. 2, 166-9 (1959). In Russian. English translation in : Soviet Physics—Acoustics (New York), Vol. 5, No. 2, 167-70 (April-June, 1959).

Measurements were made at frequencies of 0.5, 1 and 2 Mc/s of the propagation characteristics of waves, with $p \sim 0.1$ to 3 atm., in acetic acid at various concentrations. Wave behaviour was shown to be determined basically by the large absorption coefficient of the liquid which hinders development of higher harmonics. Experimental values of dispersion etc. were in satisfying agreement with calculations based on a formula derived by approximate theory.
C.R.S.Manders

534.23

996 SONIC AND ULTRASONIC WHISTLE FOR THE APPLICATION OF ACOUSTIC VIBRATIONS TO LIQUIDS AND GASES. H.Hagedorn.
Wiss. Z. Hochsch. Maschinenbau Karl-Marx-Stadt, Vol. 1, No. 1, 52-60 (1958/59). In German.

The effects of sonic and ultrasonic vibrations on water, lubricating oil, emulsions, dyes, smoke (dust precipitation effect) are discussed. A special vibration generator was developed, based on the Pohlmann-Janovsky hydraulic ultrasonic whistle, working with a blade-shaped jet of water. The working range is 0.5-50 kc/s. Full details of the results of the experiments and of the theory and design of the whistle are given.
J.Smuts

534.23 : 535.3 : 533.7

THE OPTICO-ACOUSTIC EFFECT IN GASES.
See Abstr. 967-71

534.23

997 OPTICAL INVESTIGATIONS OF A LARGE-AMPLITUDE ULTRASONIC WAVEFORM IN A LIQUID. V.A.Shutilov.
Akust Zh., Vol. 5, No. 2, 231-40 (1959). In Russian. English translation in : Soviet Physics—Acoustics (New York), Vol. 5, No. 2, 230-8 (April-June, 1959).

The author uses the light intensity distribution in a diffraction pattern, obtained from the diffraction of light by large-amplitude ultrasonic waves, to determine the shape of an ultrasonic wave and to follow its distortion during the process of propagation in a liquid. It is shown to be feasible to use the connection between wave form and light intensity distribution in the diffraction pattern for determining the absolute values of intensity of the waves discussed.
C.R.S.Manders

534.23

998 THE THEORY AND COMPUTATION OF COMPOSITE CONCENTRATORS. L.G.Merkulov and A.V.Kharitonov.
Akust Zh., Vol. 5, No. 2, 183-90 (1959). In Russian. English translation in : Soviet Physics—Acoustics (New York), Vol. 5, No. 2, 183-90 (April-June, 1959).

The ultrasonic concentrators considered consisted of three sections, the two outer being of different cross-section, and the centre part being a rod of variable or constant cross-section. Expressions are found in general form for the resonance conditions, amplification factor and input resistance. A numerical analysis was made of practical cases of some importance and optimal shapes found. There was notably good agreement between calculated and experimental values for the amplification factor whilst the resonance frequency found experimentally tended to be lower than the theoretical value and to be somewhat dependent upon the shape of the transition section of the concentrator.
C.R.S.Manders

534.23

999 APPARATUS FOR THE GENERATION OF FOCUSED ULTRASONICS OF HIGH INTENSITY.
L.D.Rozenberg and M.G.Sirotyuk.
Akust. Zh., Vol. 5, No. 2, 206-11 (1959). In Russian. English translation in : Soviet Physics—Acoustics (New York), Vol. 5, No. 2, 206-10 (April-June, 1959).

The paper gives the constructional details of an ultrasonic concentrator of hemispherical form consisting of a 300 mm diameter Al shell excited by 200 X-cut quartz piezoelectric crystal plates of 40 mm diameter distributed over the outer surface. Intensities of 60-70 kW/cm^2 are obtained at the focus. Preliminary tests show that linear phase aberrations do not affect the shape of the focal spot.
C.R.S.Manders

534.23

1000 SPATIAL AND TEMPORAL ABSORPTION IN A VISCOUS MEDIUM. D.Mintzer and B.S.Tanenbaum.
J. Acoust. Soc. Amer., Vol. 32, No. 1, 67-71 (Jan., 1960).

The relation between spatial and temporal absorption for acoustic waves in a viscous medium is discussed by considering the problem of a viscous-liquid filled tube with a piston at one end and a reflecting termination. The solution of the problem is found in terms of travelling waves from image sources, and standing waves in a tube. The phase velocity and attenuation of the steady-state terms for both solutions are the same. The transient part of the standing wave solution gives rise to the usually plotted velocity and temporal attenuation; it is shown that these do not have the same meaning as in the spatial absorption case, since they depend upon the allowed wave numbers of the system, that is, upon the geometry and boundary condition.

534.24

1001 EXPERIMENTAL INVESTIGATION OF NON-SPECULAR REFLECTION OF SOUND BY THIN FINITE RODS IN WATER. L.M.Lyamshev and S.N.Rudakov.
Akust. Zh., Vol. 4, No. 3, 283-5 (1958). In Russian.

Using the method derived by Lyamshev (Abstr. 5740 of 1958) theoretical values are calculated for non-specular reflection of sound by thin, finite rods of Al, steel, and brass in water, These results are compared with some experimental measurements. The non-specular reflection of sound by a thin, finite rod would be expected to be conditioned by its flexural and longitudinal vibrations and the experimental results confirm this satisfactorily. [English translation in: Soviet Physics—Acoustics (New York), Vol. 4, No. 3, 289-91 (July-Sept., 1958)].
C.R.S.Manders

534.26

1002 INVESTIGATION OF THE EXACT SOLUTIONS OF NON-STATIONARY DIFFRACTION PROBLEMS IN THE NEIGHBOURHOOD OF WAVE FRONTS. V.S.Buldyrev.
Dokl. Akad. Nauk SSSR, Vol. 129, No. 2, 291-4 (Nov. 11, 1959).
In Russian.

The author considers non-stationary diffraction in homogeneous acoustic media, limited by cylindrical or by spherical boundaries. The field amplitude is expanded in a series of powers of a parameter, which is proportional to the distance of the point of observation from the wave front. The convergence of such expansions is investigated; it is shown that the error can be expressed in terms of an analytic function of time and space coordinates.
J.K.Skwirzynski

534.26 : 538.56

THE EXCITATION, REFLECTION AND RADIATION OF SURFACE WAVES AT A WEDGE WITH GIVEN IMPEDANCE FACES.
See Abstr. 298

534.26

1003 ON THE INFLUENCE OF THE DIFFRACTION OF SOUND WAVES AROUND THE HUMAN HEAD ON THE CHARACTERISTICS OF HEARING AIDS. C.Wansdronk.
J. Acoust. Soc. Amer., Vol. 31, No. 12, 1609-12 (Dec., 1959).

A small hearing aid, hanging in an anechoic room is made to drive an a.v.c. circuit, the output signal of which is conducted to a power amplifier and loudspeaker and can be recorded on a tape. During playback of this tape, with the output of the recorder connected to the power amplifier, the same sound field as existed around the hearing aid is reproduced. If the apparatus is placed on a person in the position where it is to be worn and that person is situated so that the hearing aid is at the same point as during the recording, the output of the hearing aid during playback of the tape will indicate the influence of the diffraction around the human head.

Three specimens of hearing aid were measured on different people. The results showed that there exists a large difference between the hearing aids but no fundamental differences between the persons. The curves plotted for males and females showed the same trend, and no correlation was found with the hairdress. An attempt to replace the human head by a simple model, such as a wooden sphere or a wooden box did not succeed, the agreement of the diffraction phenomena between model and head being too poor.

534.4

1004 VISUALIZATION OF ULTRASONIC PULSES WITH A HIGH-FREQUENCY CARRIER. V.I.Makarov.

Akust. Zh., Vol. 4, No. 3 285-6 (1958). In Russian.

A piezo-electric transmitter is pulse-excited at frequencies in the range 0.8-4 Mc/s. Either a Kerr cell control of a light source, or a low-inertia capillary tube lamp, is actuated at the pulse recurrence frequency. The pulses can then be seen by a stroboscopic arrangement. Photographs are given illustrating the results obtainable, the method being applicable to both liquids and transparent solids. [English translation in: Soviet Physics—Acoustics (New York), Vol. 4, No. 3, 292-3 (July-Sept., 1958)].

C.R.S.Manders

534.4

1005 ULTRASONIC EXCITATION OF A CYLINDRICAL SHELL. Yu.M.Kuz'michev and V.I.Makarov.

Akust. Zh., Vol. 4, No. 3, 282-3 (1958). In Russian.

Using a thermal method of visualization and cine-camera recording, it is possible to observe the process of excitation of ultrasonic oscillations in shells, placed in a liquid, when they are illuminated by ultrasonics. The acoustic field both inside and outside the shell can also be observed. The presence on the shells of "excitation" zones is established, being regions where the incident waves are in coincidence with the waves set up in the shell. [English translation in: Soviet Physics—Acoustics (New York), Vol. 4, No. 3, 287-8 (July-Sept., 1958)]. C.R.S.Manders

534.4 : 538.56

1006 DESIGN OF DIRECTIONAL ARRAYS. J.L.Brown, Jr and R.O.Rowlands.

J. Acoust. Soc. Amer., Vol. 31, No. 12, 1638-44 (Dec., 1959).

From the application of information theory, it is found that for low signal-to-noise ratios, there is no better method of increasing the information content of a signal than to add the outputs of the elements of an array to improve the signal-to-noise ratio. When the signal-to-noise ratio is already high, however, the array should be designed so that independent information is supplied by each element when associated with a reference element. The possibility of increasing directionality by nonlinear operations is then discussed. In particular, it is shown that, for the noiseless case, a two-element array can be made to yield patterns equivalent to those produced by an n-element linear array. Linear maximum directivity arrays (in the sense of Pritchard) may also be synthesized with three omnidirectional elements and a number of nonlinear operations which remains invariant as the order of the equivalent linear array is increased. Finally linear methods designed to minimize the mean squared error are considered and it is found that array rotation is capable of giving optimum results under certain circumstances.

534.4

1007 STANDARD CALIBRATION HYDROPHONE. C.C.Sims.

J. Acoust. Soc. Amer., Vol. 31, No. 12, 1676-80 (Dec., 1959).

A new calibration standard hydrophone for use in the frequency range 5 c/s to 150 kc/s is described. The active element is a lithium sulphate crystal on a tungsten backing plate. The free-field voltage sensitivity (end-of-cable) is -90 ± 3 dB re 1 V per μbar throughout most of the frequency range. The sensitivity is little affected by temperature changes in the range 1° to 25°C, and is not affected by hydrostatic pressure changes in the range 0 to 1000 p.s.i. gauge. Directivity patterns are very nearly those to be expected from a 1 in. piston.

534.64 : 621.395.625.77

1008 SOUND TRANSMISSIVITY OF FABRIC SCREENS, WOOD MESH SCREENS AND CINEMA SCREENS. J.Steinert.

Hochfrequenztech. u. ElektAkust., Vol. 67, No. 6, 169-74 (March, 1959). In German.

Reference is made to screens used for radio receivers, the materials of which besides their aesthetic function must not damp the sound appreciably nor perceptibly modify the sound picture. In modern cinemas the screen must not only reflect the light but must also transmit, with a minimum of attenuation, the sound from the loudspeaker groups behind the screen. Measurements have been made of the sound transmission coefficients of various types of screen in the frequency range 10^2 to 10^4 c/s. The materials used varied from fabrics to wood mesh and solid walls with perforations.

A.B.Wood

534.8

1009 SCALAR ACOUSTIC FIELD THEORY APPLICATION TO THE ANALYSIS OF THE ACOUSTIC PATH OF AN ULTRASONIC FLAW DETECTOR. I.N.Ermolov.

Akust. Zh., Vol. 5, No. 2, 247-9 (1959). In Russian. English translation in : Soviet Physics—Acoustics (New York), Vol. 15, No. 2, 248-50 (April-June, 1959).

An expression is quoted for the average velocity potential of the wave reflected from a disc cavity in an infinite medium back to the transducer-receiver disc, derived from theory due to Knopoff (Abstr. 3581 of 1956) and Leitner (Abstr. 6041 of 1949). The theoretical signal amplitude—distance and amplitude—size relations are compared with data due to Morgan [Nondestructive Testing, Vol. 12, No. 3, 13-18 (1954)], and with experimental results of the author using samples with end-face openings with planar bottoms.

534.83 : 599.3

NOISE STRESS IN LABORATORY RODENTS. I. BEHAVIORAL AND ENDOCRINE RESPONSE OF MICE, RATS, AND GUINEA PIGS. See Abstr. 806-7

534.81

1010 THE MODULUS OF RIGIDITY AND THE TENSION PER UNIT AREA OF CROSS SECTION, ESSENTIAL PARAMETERS CONTROLLING THE MUSICAL RESPONSE OF A VIBRATING HARMONIC STRING. E.Leipp.

C.R.Acad. Sci.(Paris), Vol. 249, No. 3, 375-7 (July 20, 1959). In French.

Describes a study of the relation between rigidity and musical response of vibrating strings, using about 200 strings of various kinds. The strings were used in tension on a sonometer, and excited by means of a violin bow. It is shown that the sound spectrum excited in a string by bowing comprises the sum of three distinct coexistent modes of vibration with their respective harmonics; (1) transverse vibration (parameters : length, tension and linear mass), (2) longitudinal vibration (parameters: modulus of elasticity and density), (3) torsional vibration (parameters : modulus of rigidity and tension per unit area of cross-section).

A.B.Wood

534.83

1011 ON THE AERODYNAMIC NOISE OF A RIGID FLAT PLATE MOVING AT ZERO INCIDENCE. A.Powell.

J. Acoust. Soc. Amer., Vol. 31, No. 12, 1649-53 (Dec., 1959).

The aerodynamic noise resulting from the subsonic flow over a flat rigid plate at zero incidence has three origins. "Surface" noise due to fluctuating surface pressure is postulated to vanish by the author's image argument, except near the edges of the plate, where it is more appropriately called edge noise. Of dipole nature, its acoustic power depends on the velocity raised to between the fourth and fifth power, and consequently is to be expected to be of prime importance at low enough speeds. The contribution from fluctuating shear stresses is likely to be much smaller and so has been neglected. Quadrupole radiation takes place from the turbulence of the boundary layer, producing layer noise and also from the turbulent wake, producing wake noise. Together, the latter two are suggested to have a spectrum with a single peak, bounded by slopes like f^2 and $f^{-7/4}$. Their noise power depends on nearly the eighth power of velocity, so is of increasing importance with speed. Analytical details rest on similarity concepts; the spectra in particular are subject to certain conditions. Also, the convection effects on the acoustical power and spectra are excluded on empirical grounds stemming from considerations of jet noise.

534.83

1012 ON THE DESIGN OF SOUND ABSORBERS ACCORDING TO THE REFLEXION PRINCIPLE. K.Gösele.

Hochfrequentztech. u. ElektAkust., Vol. 68, No. 1, 15-18 (May, 1959). In German.

The damping of sound propagated in tubular conduits (filters, silencers etc.) may be considered by two principle methods, of sound absorption and sound reflection. The present paper considers the design of such tubular damping on the reflection principle. A series of experimental curves are shown which deal with the resonance frequencies and damping of pipe resonators of various porous pipes and combinations of pipes having varying diameters and lengths. A particular application considered is that of an exhaust silencer, using multiple bypass pipe resonators. A.B.Wood

534.83

1013 EXPERIMENTAL INVESTIGATION OF SOME VIBRATION ABSORBING MATERIALS.

N.I.Naumkina, B.D.Tartakovskii and M.M.Éfrussi.
Akust. Zh., Vol. 5, No. 2, 196-201 (1959). In Russian. [English translation in : Soviet Physics—Acoustics (New York), Vol. 5, No. 2, 196-201 (April-June, 1959)].

An experimental layout is given for measuring the dynamic elastic properties of materials employed for cutting down the vibrations propagated along the metal parts of machinery and other constructions. The materials have Young's modulus from 2 to 60 × 10^9 dyne/cm^2 and $\eta \sim 0.26$ to 0.4 i.e. $\eta E \sim 5 \times 10$ dyne/cm^2 and are used in layer form and consist in the main of bitumen impregnated with rubber with various fillers. One of the best is felt impregnated with bitumen and covered with mastic on an asbestos base.
C.R.S.Manders

534.83

1014 THIN WALLS IN ACOUSTIC INSULATION.

J.Frenkiel.
Bull. Sci. Assoc. Ingen. Montefiore (A.I.M.), Vol. 72, No. 4-5, 347-73 (April-May, 1959). In French.

In older forms of construction to achieve acoustic insulation, separating walls were made of brick or heavy masonry, the rigidity and weight of which provided sufficient attenuation of sounds. The general tendency to reduce the weight of dividing walls or partitions has posed an important problem in acoustic insulation. When thin partitions are exposed to the vibrations of a local sound source, the sounds are transmitted according to the different modes of vibration of the partition, which in turn depend on the frequency of the vibrating source and the dimensions of the partition. A study has been made of such vibrations and of the possibilities of using thin partitions in sound insulation construction. A.B.Wood

534.83

1015 THE DESIGN OF RESONANT SOUND ABSORBERS AND THEIR APPLICATION FOR REGULATION OF REVERBERATION AND SOUND ABSORPTION [IN AUDITORIA].

S.N.Rschevkin.
Hochfrequenztech. u. ElektAkust., Vol. 67, No. 4-5, 128-35 (Jan., 1959). In German.

The design and use of resonant sound absorbers for walls and ceilings of auditoria is discussed. The simple resonant absorber consists of a plane layer of solid material pierced with a regular series of holes and spaced at a definite distance from the wall or ceiling surface to be acoustically treated. The diameter and spacing of the holes is important. A multiple layer system is also discussed where the layers, which have different hole sizes and spacing, are arranged one behind the other at non-regular intervals. In this arrangement a very efficient absorbing system is obtained covering a frequency range from low to moderately high frequencies. Examples are given of the performance of two layer resonant absorber systems on ceilings and walls of auditoria. The effects of these arrangements in controlling sound absorption and reverberation time at different frequencies are indicated.
A.B.Wood

534.83

1016 RESEARCH ON A HIGH EFFICIENCY SOUND ABSORBING SYSTEM. K.A.Welischanina.

Hockfrequenztech. u. ElektAkust., Vol. 67, No. 4-5, 147-9 (Jan., 1959). In German.

Measurements have been made of the physical properties of acoustically absorbent cones and wedges as used in anechoic rooms. Wave-impedance, acoustic density, modulus of volume elasticity, sound velocity and propagation (Ausbreitung) constant were measured over a wide frequency range. A series of curves are shown, indicating the very low coefficient of sound-reflection for a cone of height 75 cm and filling-density 0.128/cm^2 under various conditions. The measurements were made with a single cone of wood wool or glass wool in a Kundt's tube. A.B.Wood

534.84

1017 THE INFLUENCE OF RATE OF FLOW VALUES ON THE DETERMINATION OF THE DYNAMIC STIFFNESS OF POROUS DAMPING MATERIALS. W.Kraak.

Hochfrequenztech. u. ElektAkust., Vol. 67, No. 4-5, 111-13 (Jan., 1959). In German.

Discusses damping properties of the floating floor, as used for sound insulation in high buildings. The required eigenfrequency should be sufficiently low, in general, under 100 c/s. The dynamic stiffness and hence the frequency are calculated for a layer of porous damping material. In general it is found that the air of the damping layer cannot freely escape and therefore cannot follow the motion of the external air. The dynamic stiffness of the damping layer consequently lies between two limiting values which are determined theoretically. A.B.Wood

534.84

1018 DETERMINATION OF SECONDARY PATHS FOR AIR-BORNE SOUND [IN BUILDINGS] BY THE METHOD OF STRUCTURE SOUND MEASUREMENT AND STRUCTURE SOUND EXCITATION. W.Erler.

Hochfrequenztech. u. ElektAkust., Vol. 67, No. 4-5, 105-11 (Jan., 1959). In German.

Using a method developed by Meyer, Parkin, Oberst and Purkis [Acustica, Vol. 1, No. 1, 17 (1951)], the author describes a series of observations over a frequency range extending up to 3000 c/s of sound transmitted from one room to another via floors, ceilings and walls of buildings by indirect paths. The relative effects of the various transmission paths through solid structures is represented in a series of curves as a function of frequency.
A.B.Wood

534.84

1019 SOUND DAMPING MEASUREMENTS IN GLASS SHEETS AS A FUNCTION OF ANGLE OF INCIDENCE.

A.Eisenberg.
Hochfrequenztech. u. ElektAkust., Vol. 67, No. 4-5, 113-16 (Jan., 1959). In German.

An experimental investigation of the sound transmission through glass windows at varying angles of incidence in the frequency range 100 to 3200 c/s is described. Windows in a 100 m^3 room with glass up to 15 mm thick, mounted on rubber, were examined. A corresponding series of measurements were also made with double-layer glass windows separated at the edges either by rubber or other sound damping material. A.B.Wood

534.84

1020 THE ACOUSTIC PROPERTIES OF ROOM ABSORBERS.

I.Malecki.
Hochfrequenztech. u. ElektAkust., Vol. 67, No. 4-5, 124-7 (Jan., 1959). In German.

A theoretical discussion of sound absorbent surfaces, walls and ceilings of rooms, regarded as plane smooth surfaces or as plane surfaces covered with irregularities such as small spheres (rad. R) or cubes spaced at intervals D (≤ 8 R). The effect of a single "room absorber", a small sphere, is first considered in a diffuse sound field; then the effect of a layer of such absorbers for different values of R/D, the absorption coefficient being plotted as a function of frequency. A.B.Wood

534.84

1021 THE SOUND ABSORPTION OF SINGLE RESONATORS IN AN INFINITE WALL. W.Wöhle.

Hochfrequenztech. u. ElektAkust., Vol. 67, No. 4-5, 140-6 (Jan., 1959). In German.

Resonance curves are derived theoretically for a single resonator in an infinite wall for varying degrees of damping. An experimental curve shows good agreement with theory. The effective absorption area of the resonator is calculated also for all angles of incidence. A.B.Wood

534.84

1022 THE MEASUREMENT OF THE SOUND ABSORPTION COEFFICIENT IN REVERBERATION ROOMS, AS DEPENDENT ON THE ARRANGEMENT OF THE MATERIALS.

F.Kolmer.
Hochfrequenztech. u. ElektAkust., Vol. 67, No. 4-5, 153-60 (Jan., 1959). In German.

The paper gives the results of experimental observation of sound absorption coefficient measurements in a reverberation chamber using many different kinds of sound absorbent surface, varying the area and the distribution of material. Curves are given for the various materials showing the variation of absorption coefficient as a function of the area of the specimen. Other curves show the effect of frequency variation for different distributions of the absorbent material in the reverberation room, e.g. concentrated near one corner of the room, or distributed over one, three or five walls of the room. The results are of considerable practical significance in the design of auditoria. A.B.Wood

534.84

1023 THE ABSORPTION OF SINGLE RESONATORS FOR DIFFERENT ARRANGEMENTS IN CLOSED ROOMS

(NEAR MIDDLE OF ROOM, EDGES OF WALLS, AND CORNERS). W.Wöhle.
Hochfrequenztech. u. ElektAkust., Vol. 67, No. 6, 180-7 (March, 1959). In German.

(For earlier work, see Abstr. 4485 of 1955; 5744 of 1956). The paper gives a theoretical treatment of the problem and goes on to describe experimental observations using a single Helmholtz resonator in support of the theoretical treatment. A.B.Wood

534.84

1024 MEASUREMENT OF REFLECTION EFFECTS BY THE CORRELATION METHOD. S.Gerschmann.
Hochfrequenztech. u. ElektAkust., Vol. 67, No. 4-5, 161-3 (Jan., 1959). In German.

See Abstr. 4472-3 (1955) for similar work. The acoustic properties and quality of acoustic performance of a room were studied using the relationship between the direct and reflected sound waves, their energies, their propagation times, and their frequency distortion. The cross-correlation coefficient R was derived for the effective value of the transmitted signal and the received sound, under various experimental conditions in the frequency range 1200 to 6400 c/s. A series of curves are shown indicating the variation of R for the acoustic ratio σ_1/σ_2; the noise level of the room; the energy scattering of the direct sound; the square of energy of the direct sound; and the reflection energy. Measurements were made with varying distances between source and receiver and in the two frequency octaves 1200-2400 c/s and 3200-6400 c/s. A.B.Wood

534.86

1025 ON THE LOCALIZATION OF AN APPARENT SOUND SOURCE IN TWO-CHANNEL STEREOPHONIC TRANSMISSION. V.S.Man'kovskii.
Akust. Zh., Vol. 5, No. 2, 176-82 (1959). In Russian. English translation in : Soviet Physics—Acoustics (New York), Vol. 5, No. 2, 177-82 (April-July, 1959).

Using a two-channel stereophonic transmission the author derives from his experimental results some data concerning the perception of an apparent sound source. It is found that the latter's position as observed by a listener depends not only on the difference of sound level from the two loudspeakers but also on the coordinates of the point of observation. It is concluded therefore that a two-channel stereophonic system cannot be recommended for sound cinematography since it does not ensure good coincidence of apparent source of sound and image on the screen. C.R.S.Manders

OPTICS . PHOTOMETRY

535.1

1026 ELEMENTARY CONSIDERATIONS ON THE DYNAMICS OF LIGHT WAVES. G.Györgyi.
Amer. J. Phys., Vol. 28, No. 2, 85-8 (Feb., 1960).

An elementary treatment of the dynamical aspects of light refraction and Cherenkov radiation is given. Although some authors have given preference to the Minkowski energy—momentum tensor in the interpretation of these effects, the treatment presented here shows that the rival theory of Abraham is fully capable of describing them correctly. A crucial point for the settlement of the old polemic concerning the energy—momentum tensors of Abraham and of Minkowski, is recognized to be the existence of the Lorentz force acting on polarization currents. The Abraham energy—momentum tensor yields an adequate expression containing this type of force, but the Minkowski one fails to describe this phenomenon.

GEOMETRICAL AND INSTRUMENTAL OPTICS SPECTROSCOPY

(Optical spectra and their analysis are included under the appropriate heading, e.g. Atoms, Molecules, Solid-State Physics, etc.)

535.1 : 523.16

A RADIO-ASTRONOMICAL TEST OF THE BALLISTIC THEORY OF LIGHT EMISSION. See Abstr. 834

535.3 : 534.23 : 533.7

THE OPTICO-ACOUSTIC EFFECT IN GASES. See Abstr. 967-71

535.31

1027 INVESTIGATION OF THE EFFECTS OF ERRORS IN THICKNESSES AND SEPARATIONS ON THE GAUSSIAN PROPERTIES OF AN OPTICAL SYSTEM. J.Klebe.
Optik, Vol. 16, No. 9, 563-72 (Sept., 1959). In German.

Derives formulae for changes in image position, transverse magnification and equivalent focal length caused by thickness variations. In a numerical example results from the formulae are compared with those from exact computation. W.T.Welford

535.31

1028 DETERMINATION OF THE CONTRAST TRANSFER FUNCTION FROM THE IMAGE OF AN EDGE.
K.Rosenhauer and K.J.Rosenbruch.
Z. InstrumKde, Vol. 67, No. 7, 179-85 (July, 1959). In German.

The contrast transfer function can be determined as the Fourier transform of the image of an edge. This avoids errors in the manufacture of periodic test-charts. Apparatus was built in which the transform was obtained directly by variable electrical filter circuits. Results of measurements through focus and off axis for an F/2.0 50 mm photographic objective are given. There are 19 references. W.T.Welford

535.8

1029 ABERRATION SYNTHESIZER.
D.L Fridge.
J. Opt. Soc. Amer., Vol. 50, No. 1, 87 (Jan., 1960).

A telescopic system incorporates movable elements by means of which varying spherical aberration, coma and astigmatism and longitudinal and transverse colour are produced on axis. The amounts range up to approximately 3 wavelengths of aberration of either sign. W.T.Welford

535.8

1030 ON ELIMINATION OF THE DOUBLET STRUCTURE IN THE TRANSMISSION BAND OF A TOTAL-REFLECTION LIGHT FILTER. P.G.Kard.
Optika i Spektrosk., Vol. 6, No. 3, 389-93 (March, 1959). In Russian.

The author described earlier [Izvestiya Akademii Nauk Estonskoi SSR, Vol. 6, 344 (1957)and Abstr. 7993 of 1959] a total-reflection light filter consisting of three layers (with refractive indices n_1, n, n_1) placed between two glass prisms. The outer two layers were totally reflecting (refractive index n_1). The disadvantage of such a filter is that its transmission band has two peaks ("doublet structure"). This doublet structure can be eliminated by using seven layers in the filter. Each of the two totally reflecting layers is placed between two "correcting" layers with refractive index n_k. The seven layers of the filter can be represented by their refractive indices as follows: $n_k n_1 n_k n n_k n_1 n_k$. The condition for the absence of the doublet structure is given by $n_k^2 = nn_1$. A.Tybulewicz

535.8

1031 VERTICAL, HORIZONTAL AND INVERTED MICROSCOPE IN CONJUNCTION WITH A FILM CAMERA, WITH A RAPID CHANGE OF FUNCTION AND SMALL WEIGHT. W.Kuhl and H.Fischer.
Z. wiss. Mikr., Vol. 64, No. 2, 73-83 (Jan., 1959). In German.

535.33

1032 DEVICE FOR OPTICAL FILTER SELECTION FOR USE WITH GRATING SPECTROMETERS. W.J.Condell.
Amer. J. Phys., Vol. 27, No. 8, 603-4 (Nov., 1959).

The principle of the device is explained and details are outlined for its construction. E.G.Knowles

535.33

1033 ON THE THEORY OF THE SPECTROPHONE. R.Kaiser.

Canad. J. Phys., Vol. 37, No. 12, 1499-513 (Dec., 1959).

The spectrophone consists essentially of a constant gas volume that is exposed to intensity-modulated infrared radiation of a spectral range corresponding to one of the vibration—rotation bands of the gas. After a brief review of the history of the instrument a theoretical analysis of the processes in the spectrophone cell is presented on the basis of a two-state gas model. Expressions are derived for the time dependence of the upper-state population, of the gas pressure, and of the infrared absorption, emphasizing the effects due to a finite rate of exchange between vibrational and translational energy of the gas molecules. Numerical values are calculated for the 15μ CO_2 band and it is suggested that information on the mechanism of vibrational relaxation in polyatomic gases and gas mixtures can be obtained from experimental studies of the gas pressure in the spectrophone cell.

535.33

1034 OPTIMUM OPTICAL DENSITY FOR "SHOT" NOISE LIMITED SPECTROPHOTOMETERS. B.G.Wybourne.

J. Opt. Soc. Amer., Vol. 50, No. 1, 84-5 (Jan., 1960).

A high gain photomultiplier approximates to this condition and it is shown that the optimum optical density should be 0.87; at higher values the error is only slightly increased. G.F.Lothian

535.33

1035 ACCURACY OF DETERMINATION OF WAVELENGTHS WITH VARIOUS INTERPOLATION FORMULAE FOR WORK WITH A DIFFRACTION-GRATING SPECTROGRAPH DFS-3. V.A.Loginov.

Optika i Spektrosk., Vol. 6, No. 5, 692-4 (May, 1959). In Russian.

The author establishes two relationships which give the value of the spectral interval l within which the error arising from the use of (i) a linear or (ii) a quadratic interpolation formula does not exceed a certain value N (in A). These relationships are then applied to the particular case of a spectrograph DFS-3 with a 1200 or 600 lines/mm diffraction grating and F = 4000 mm. It is found that when a linear interpolation formula is used in the first-order spectrum the value of l for N = 0.001 A varies with the mean wavelength (λ_0) of the region studied. For $\lambda_0 = 2000$ A, $l = 11$ mm (equivalent to 10 A for a 1200 lines/mm grating and to 20 A for a 600 lines/mm grating). When a quadratic interpolation formula is used under the same conditions, l is independent of λ_0 between 2000 and 10 000 A; the mean values of l for 1200 and 600 lines/mm gratings are then 53.6 and 42.5 mm respectively (corresponding to 108 and 172 A respectively). A.Tybulewicz

535.39

1036 EFFECT OF THE SPEED OF FORMATION OF A THIN LAYER OF GOLD ON THE CHANGES OF PHASE THAT A LIGHT WAVE UNDERGOES WHEN REFLECTED BY THE METAL INTO AIR OR A QUARTZ SUBSTRATE. R.Philip.

C.R. Acad. Sci. (Paris), Vol. 248, No. 25, 3543-5 (June 22, 1959). In French.

The phase changes, Δr and $\Delta r'$, at the gold-air and gold-quartz interfaces were measured for three different evaporation rates, four different wavelengths between 3300 A and 5500 A and for film thicknesses ranging from 0 to 700 A. Δr tended to be greater for films deposited more rapidly, particularly when it was measured at shorter wavelengths and for larger film thicknesses. $\Delta r'$ was much less susceptible to evaporation rate. B.T.M.Willis

PHYSICAL OPTICS

(Luminescence is included under Solid-State Physics, Liquid State, or Gaseous State)

535.41 : 522.6

INTERFEROMETRY OF THE INTENSITY FLUCTUATIONS IN LIGHT. See Abstr. 823-4

535.41

1037 LIMITING PRECISION IN OPTICAL INTERFEROMETRY. G.R.Hanes.

Canad. J.Phys., Vol.37, No.11, 1283-92 (Nov., 1959).

The fundamental limit to the precision of setting on a fringe peak due to photon noise is evaluated for a certain class of interferometric methods in terms of parameters characterizing the source, the interferometer, and the detector. It is shown that changes in path difference of 10^{-10} should be detectable with an observing time of 1 sec, using only modest equipment. Some of the experimental conditions required to attain this precision are discussed.

535.41

1038 THE ASSESSMENT OF HIGH REFLECTING FILMS FOR INTERFEROMETRY OR MONOCHROMATIC FILTERS. S.Tolansky.

Lab. Pract., Vol. 8, No. 8, 265-7 (Aug., 1959).

High efficiency in the high reflecting films for interferometry and for monochromatic filters involves both a high reflectivity and a low absorption. A simple image counting method is described which permits of rapid selection of suitable reflecting films. Two reflectors are slightly inclined and a small bright source (Pointolite) viewed. The count of multiple images is a sufficient test for selecting reflecting films. A good film gives 80 or more images. An interference fringe pattern produced by such an image count is illustrated. S.Tolansky

535.41 : 536.46

1039 INTERFEROMETRIC ETALON FILTER FOR APPARATUS FOR DETERMINING THE TEMPERATURES OF FLAMES. C.Veret.

Rev. Opt., Vol. 38, No. 7, 317-44 (July, 1959). In French.

Flame temperatures are measured from line reversal created by introducing Na in the flame and measuring absorption. The monochromatic filter used consists of a series of Fabry—Perot interferometers. Filter properties of the system are reviewed. Filters used are 8, 21 and 43 μ thick. Luminosity considerations are examined. The apparatus used is described in detail. Mechanical mounting is illustrated. Measurements are reported for transparency and finesse for etalons with 5 and 7 multilayers. S.Tolansky

535.41 : 531.71

1040 MEASUREMENT OF THICKNESS OF FILMS USING EQUAL-CHROMATIC-ORDER LINES. I.N.Shklyarevskii.

Optika i Spektrosk., Vol. 5, No. 5, 617-19 (1958). In Russian.

In 1945 Tolansky used equal-chromatic-order lines in the study of the topography of almost plane surfaces, using white light. Later Sinel'nikov and Rapp (1950) and the author (1954, 1956) applied Tolansky's method to the thickness measurement of films deposited in vacuo on glass plates. A scratch is made across such a film. The film is then covered (by vacuum deposition) by an opaque layer of silver which repeats the scratch contours forming a small step. The height of this step is equal to the original film thickness. A second glass plate is covered by a semi-transparent layer of silver. The two plates are pressed together and are placed in front of a spectrograph slit in such a way as to position the step, referred to above, at right angles to the slit. These plates are illuminated with a parallel beam of white light. An achromatic lens is used to focus the air gap between the glass plates on to a spectrograph slit. In the focal plane of the spectrograph camera objective two systems of equal-chromatic-order lines are observed and the separation between the two systems of lines is a function of the original film thickness. The paper gives formulae necessary for the calculation of thickness from the observed interference pattern. A.Tybulewicz

535.41 : 531.71

1041 MEASUREMENT OF SMALL DISPLACEMENT BY USING NEWTON'S RINGS AND AN OBJECTIVE MICROMETER. I.Ikeda.

Mem. Fac. Engng Hokkaido Univ., Vol. 10, No. 46, 491-503 (Oct., 1958).

Some details are given of the application of Newton's rings methods to the measurement of small displacements. Possible sources of error are examined in detail and a number of examples are illustrated. The method described is applied to the investigation of the ageing of pieces of concrete. S.Tolansky

535.42

1042 ASPHERICAL DIFFRACTION GRATING WITH ONE PLANE OF SYMMETRY. I. ABERRATIONS OF AN ASPHERICAL GRATING. Yu.P.Shchepetkin.

Optika i Spektrosk, Vol. 4, No. 3, 383-95 (1958). In Russian. English summary: PB 141047T-4 obtainable from Office of Technical Services, U.S. Dept. of Commerce, Washington, D.C. U.S.A.

The paper deals theoretically with properties of a concave reflection grating ruled on an aspherical surface with a single plane of symmetry. It is shown that aberrations (astigmatism, coma, spherical aberration) may be corrected for any two conjugate points. Best results are obtained by placing the grating on the circumference of the Rowland circle and correction of aberration for points lying on this circumference. The formulae obtained are suitable for analysis of properties and for calculation of aberrations of a large group of diffraction gratings, such as plane, cylindrical, spherical, elliptical, parabolic, hyperbolic, toroid, aspherical with one or two planes of symmetry, and other gratings, as well as for mirrors with the corresponding profiles.

535.42 : 551.5

DIFFRACTION MICROSCOPY AND THE IONOSPHERE. See Abstr. 757-8

535.42

1043 CONTRIBUTION TO THE THEORY OF DIFFRACTION OF LIGHT BY ZONE PLATES. J.Moser.

Annu. Fac. Phil. Skopje, Sect. Sci. Nat., Vol. 10, 75-85 (1957). In Serbo-Croat.

The distribution of light intensities along the optical axis of zone plates is calculated on the basis of the Kirchhoff's theory of diffraction. F.Lachman

535.43 : 539.12

1044 OPTICAL CONDITIONS WITHIN A WEAKLY ABSORBING SCATTERING MEDIUM AND CERTAIN POSSIBILITIES IN SPECTROSCOPY. G.V.Rozenberg.

Optika i Spektrosk., Vol. 5, No. 4, 440-9 (1958). In Russian.

Discusses optical conditions within a weakly absorbing isotropic scattering medium. The treatment applies both to electromagnetic waves and to spin-$\frac{1}{2}$ particles. It is shown that with increase of specific absorption of the medium the steady-state intensity indicatrix becomes more extended in shape and consequently steady-state polarization of emission appears. Dependence of the emission intensity on depth is given by an exponential law with a decay constant which is not equal to the coefficient of extinction, but which is proportional in the first approximation to the square root of the product of the absorption and extinction coefficients. The constant of proportionality depends on the form of the scattering indicatrix. Spectroscopic applications of the formulae obtained to measurements of the absorption and scattering coefficients are indicated. A.Tybulewicz

535.51

1045 GERMANIUM POLARIZERS FOR THE INFRARED. R.Meier and H.H.Günthard.

J. Opt. Soc. Amer., Vol. 49, No. 11, 1122 (Nov., 1959).

Discusses suitability of germanium and gives details and results of a practical polarising set-up. P.A.Young

535.51

1046 LIGHT PROPAGATION IN ABSORBING CRYSTALS POSSESSING OPTICAL ACTIVITY—ELECTROMAGNETIC THEORY. S.Pancharatnam.

Proc. Indian Acad. Sci. A, Vol. 48, No. 4, 227-44 (Oct., 1958).

The propagation of light along an arbitrary direction in an absorbing active crystal is solved by extending the treatment previously given (Abstr. 7330 of 1956) for transparent active crystals — the index tensor and the modified gyration tensor being replaced by corresponding tensors with complex components. The two waves are in general elliptically polarized, in states identical with those given by a method of superposition (Abstr. 4884 of 1958); their velocities and absorption coefficients are likewise simple functions of the parameters which specify these states of polarization on the Poincaré sphere. Attention is drawn to the propagation along any singular direction (in active or inactive crystals) where only one homogeneously polarized plane wave solution is obtained — and not two. A more general theoretical approach (see Abstr. 3657 of 1956) becomes necessary to establish — in agreement with experiment — that other solutions also exist, representing plane disturbances propagated with a progressive change of polarization. For such a disturbance the wave equation satisfied by the displacement vector differs from the usual form only in that the square of the velocity has to be regarded as a tensor operator.

535.56

1047 IMPROVEMENT OF A PHOTOELECTRIC POLARIMETER OF GREAT SENSITIVITY INTENDED FOR MEASUREMENT OF THE FARADAY EFFECT. J.Breton.

C.R. Acad. Sci. (Paris), Vol. 249, No. 4, 526-7 (July 27, 1959). In French.

Improvements of an earlier apparatus are described. Smaller cells and coils are used and an electronic power supply now replaces the batteries. The cells hold 8 cm^3 of liquid and are made of Teflon. The coils are 5 cm long, 5 cm in diameter and have 1870 turns of wire carrying 1 A. The field strength produced is 260 Oe. The circuit for the power supply is given. The accuracy of the instrument when measuring rotations of about 0.5° is better than ±0.1 second. H.G.Jerrard

COLORIMETRY . PHOTOGRAPHY

535.65

1048 CONVENIENT COLOR INDICES FOR NEAR-WHITE SAMPLES. E.Allen.

J.Opt. Soc. Amer., Vol. 49, No. 12, 1227-8 (Dec., 1959).

The derivation of expressions for yellow and dark indices is given for use with both a photo-electric colorimeter and a spectrophotometer. R.A.Weale

77 : 522.6

1049 UTILIZING EMULSION THICKNESS VARIATION WITH BLACKENING. H.Schmidt.

Optik, Vol. 16, No. 9, 538-62 (Sept., 1959). In German

Describes stellar photometry studies using emulsion thickness variation as a measure of intensity. The properties of common spectrographic emulsions are investigated and the various processes used in development and drying are considered. An examination of plates exposed in 1935 shows that these may still be measured by this technique. Photographic edge effects cause gelatine deformations around high density areas and special care has to be taken in measuring these. R.W.Fish

HEAT . RADIATION

536.2

1050 HEAT TRANSFER TO BOILING NITROGEN. J.Ruzička.

Bull. Inst. Internat. Froid, Annexe 1958-1,323-9.

An experimental study of the heat transfer rates between heated Cu tubes, Cu and Pt wires and evaporating nitrogen under atmospheric and reduced pressures. The heat flux and heat transfer coefficient α were determined as a function of the temperature difference between the specimens and the nitrogen in the natural convection and the nucleate boiling regions. The results are shown graphically and equations for α are derived. S.Weintroub

536.21

1051 FLAT PANEL VACUUM THERMAL INSULATION. H.M.Strong, F.P.Bundy and H.P.Bovenkerk.

J. appl. Phys., Vol. 31, No. 1, 39-50 (Jan., 1960).

Evacuated mats of glass fibre made up of fibres of proper size and orientation are capable of supporting a compressive mechanical loading of at least 1 atm and yet maintain a thermal conductivity of less than 10 mcal cm^{-1} deg^{-1} sec^{-1}. The use of such a glass fibre mat as a filler makes possible an evacuated flat-panel thermal insulation which is comparable to a Dewar flask in insulation efficiency. The rate of heat transfer through a Dewar flask wall was reduced several-fold at liquid nitrogen temperatures and below by adding a 2 cm thick layer of orientated and evacuated glass fibre mat to the outer surface. This investigation showed that in evacuated glass fibre mats, supporting external atmospheric loading, the fibre to fibre contact area is less than 10^{-4} the mat area, making the contact pressure about 15 000 kg/cm^2. The effective length of the thermal conduction paths along the fibres is about four times the mat thickness. The mean pore size for gas molecule motion in the mat was found to be about 54 × 10^{-4} and 2 × 10^{-4} cm for mean fibre sizes of 14 × 10^{-4} and 0.2 × 10^{-4} cm, respectively. The radiation mean free paths for the same fibre sizes were found to be 150 × 10^{-4} and 52 × × 10^{-4} cm, respectively. The thermal diffusivity is about 10^{-4} cm^2/sec, which is much smaller than any other insulating material.

536.21

1052 NONLINEAR HEAT TRANSFER PROBLEM. P.L.Chambré.

J. appl. Phys., Vol. 30, No. 11, 1683-8 (Nov., 1959).

A study has been made of the time-dependent heat conduction in a semi-infinite medium subject to a boundary condition which can involve the temperature in a nonlinear manner. A formulation for the determination of the surface temperature, which is often of greatest physical interest, leads to a nonlinear Volterra integral equation. A simple iterative solution method, with an accuracy suitable for many practical purposes is presented. As an example, the problem of the time-dependent surface temperature of a body receiving heat according to the Stefan—Boltzmann law is treated. The analysis is also applicable to physical adsorption or chemisorption processes which occur at the boundary.

536.23

1053 HEAT LOSS FROM VERY THIN HEATED WIRES IN RAREFIED GASES. H.J.Bomelburg.

Phys. of Fluids, Vol. 2, No. 6, 717-18 (Nov.-Dec., 1959).

The heat loss from the wires was measured electrically at constant temperature and at a number of pressures from atmospheric downwards. The results indicate that thermal conductivity of the gas may depend to some extent on pressure, but no theoretical explanation of this effect has been found. R.F.S.Hearmon

536.33

1054 ON THE VALIDITY OF KIRCHHOFF'S LAW FOR A FREELY RADIATING BODY. M.A.Weinstein.

Amer. J. Phys., Vol. 28, No. 2, 123-5 (Feb., 1960).

In applying Kirchhoff's law to calculate the emission of a heated body radiating freely to the outside, one assumes that the emission of a body when radiating freely is the same as its emission when enclosed in a blackbody cavity. But the radiation field inside the body is everywhere smaller in the first case than in the second; consequently the emission arising from induced radiative transitions must be smaller for a freely radiating body than the emission arising from these transitions when the body is enclosed in a cavity. Since the emissions differ, one is apparently led to the conclusion that Kirchhoff's law cannot be valid for a freely radiating body. It is shown that this conclusion is false: Kirchhoff's law is valid as long as the distribution over material states is the equilibrium distribution, and is therefore, in this sense, independent of the state of the radiation field. One must, however, take proper account of the effect of induced emission in calculating the absorption coefficient.

536.33

1055 CROOKE'S RADIOMETER AS A MODULATOR OF RADIATION.

M.L.Veingerov, A.A.Sivkov and A.P.Petrov.

Optika i Spektrosk., Vol. 6, No. 5, 713 (May, 1959). In Russian.

The authors found that a modified Crooke's radiometer can be used as a radiation modulator. The moving system of the radiometer consisted of four mica plates blackened on one side and aluminized on the other. These plates were suspended at 45° to the vertical. Radiation flux which caused the radiometer to rotate was directed horizontally onto the blackened sides of the plates. Radiation flux to be modulated was directed vertically on to the aluminized sides of the plates and was interrupted when these plates rotated. The rate of rotation of the radiometer depended on the vacuum and on the intensity of the horizontal radiation flux, which moved the plates. The highest rate of rotation was achieved at 2×10^{-2} mm Hg with the horizontal flux intensity of 0.5 W. The radiometer rotated then at 13 rev/sec, equivalent to a modulation frequency of 52 c/s. This frequency could be decreased continuously to zero. The maximum diameter of the cross-section of the modulated beam was 10mm. Another variant of the Crooke's radiometer with two series of plates could also be used as the radiation modulator. In this case one series of plates was fixed vertically and was used for rotation of the radiometer, while the other was used to modulate a vertical radiation flux. A.Tybulewicz

536.42

1056 THE TEMPERATURE-TIME DEPENDENCE OF THE TRIPLE POINT OF WATER. R.J.Berry.

Canad. J. Phys., Vol. 37, No. 11, 1230-48 (Nov., 1959).

The important, but elusive, temperature—time dependency of the triple point of water was thoroughly investigated in 10 triple point cells from two sources. During the first 2 days after preparation of the cells, the temperature was found to increase by amounts ranging from 0 to 5×10^{-4} °C with the average rise being 2×10^{-4} °C. After the second day the temperature continued to rise at a rate of about 0.1×10^{-4} °C per day for about a week and finally stabilized. In practice, if an ice mantle in a cell is allowed to age for about three days before the cell is used the temperature should be reproducible to about 10^{-4} °C. A series of experiments are described which suggest that this initial temperature rise may well be due to the growth of crystals in the ice and/or strains in the freshly prepared ice. The slow rise after the second day could be accounted for by crystal growth. These two possibilities are discussed in detail and a formula relating the temperature to crystal size is compared with the observed results. Tests in pyrex cells up to 5 years old showed that they contain no significant amount of impurities and, therefore, that the segregation of impurities during the freezing process is not likely to be the cause of the initial temperature variations. On the assumption that the above explanations are true, a number of methods of eliminating this troublesome initial temperature rise were tested. Since none of these tests was completely successful, methods of extending the usefulness of old mantles were examined. Different methods of preparing and using the cells were critically examined; the earlier method of supercooled freezing was found to be quite inadequate. The effect of different thermal bonds in the thermometer well and of different cell environments was investigated. As a result of this work a new importance is attached to the standard practice of melting the inner layer of ice next to the thermometer well. The effect of the temperature-time dependency on previous measurements of the difference in temperature between the ice and triple points of water is discussed.

536.42

1057 EVAPORATION OF ALUMINUM OXIDE. G.W.Sears and L.Navias.

J. chem. Phys., Vol. 30, No. 4, 1111-12 (April, 1959).

The evaporation was studied in a (tungsten or tantalum) furnace in which no portion of the hot Al_2O_3 (sapphire) was in contact with solid reductant and in which the heating was produced by electron bombardment (temperatures up to 1975°C were achieved). No visible deposit occurred on the glass envelope of the furnace after heating of the oxide for 1 hour. This enabled an upper limit to be placed on the evaporation rate of Al_2O_3. The estimated equivalent pressure ($\sim 5 \times 10^{-7}$ mm Hg) is about 20-fold less than the equilibrium dissociation pressure of Al_2O_3 into its elements calculated from the free energy of formation of the oxide. W.Good

536.42

1058 EBULLIOMETRY AND THE DETERMINATION OF THE MOLECULAR WEIGHTS OF POLYMERS. III. CONSIDERATIONS ON THERMISTOR WHEATSTONE BRIDGES. W.R.Blackmore.

Canad. J. Phys., Vol. 37, No. 12, 1365-73 (Dec., 1959).

For Pts I and II see Canad. J. Chem., Vol. 37, No. 9, 1508, 1517 (Sept., 1959). It is shown that a d.c. thermistor Wheatstone bridge may be used in ebulliometry to measure the small temperature differences which are observed between the boiling points of polymer solutions and the pure solvent. A relationship is derived between the thermistor bridge unbalance voltage and the solute molecular weight, which it is desired to measure. It is shown that a bridge composed of suitably matched thermistors may be made independent of the gross changes in boiling point of both solution and solvent produced by changes in atmospheric pressure. The possibility of the current flowing through the thermistors disturbing the measurements is discussed and in situ measurements of thermistor dissipation and time constants are given. The sensitivity attainable with various thermistor bridges and modern amplifiers at full gain is calculated and shown to be much greater than may be employed with the usual type of ebulliometer. The reason for this is the relatively large background noise (random temperature fluctuations) produced in the ebulliometer by the boiling process itself.

536.46 : 535.41

ETALON FILTER FOR USE IN FLAME-TEMPERATURE DETERMINATION. See Abstr. 1039

536.46

1059 THE TEMPERATURE DISTRIBUTION IN SOOT FLAMES. F.Rössler.

Ann. Phys. (Leipzig), Folge 7, Vol. 4, No. 6-8, 396-422 (1959). In German.

It is concluded from an exhaustive discussion of the existing data on amyl acetate flames that the colour temperature depends on wavelength. If this is taken into account the true temperature can be uniquely determined, and it is shown that this removes the apparent discrepancy between the values obtained by Valentiner and Rossiger [Annalen der Physik, Vol. 76, 785 (1925)] and by Pearson and Pleasance (Abstr. 4545 of 1935). A series of nomograms useful for the determination of the temperature distribution in amyl acetate and other soot flames is given. S.Weintroub

536.51

1060 A VARIABLE SENSITIVITY GAS THERMOMETER FOR USE AT LOW TEMPERATURES.

F.Rothwarf and J.Steinberg.
Bull. Inst. Internat. Froid, Annexe 1958-1, 117-27.

An analysis is given of the sensitivity of a gas thermometer over the region from 300 to 4.2°K., showing how variable sensitivity can be obtained. A thermometer was constructed and the results obtained with it are given. E.G.Knowles

536.51 : 621.317.39

1061 CAPACITOR THERMOMETER FOR HYDROLOGIC INVESTIGATIONS.

S.S.Srivastava and V.Padmanabhan.
J. sci. industr. Res., Vol. 18B, No. 8, 345-6 (Aug., 1959).

Description of apparatus for temperature measurement in shallow waters down to 50 ft. A temperature-sensitive capacitor is employed in connection with electronic equipment. An accuracy of ±0.05° C has been obtained under laboratory conditions. A.J.Ingels

536.52

1062 ON A PYROMETRIC APPLICATION OF THE PHOTO-LUMINESCENCE OF A ZINC CADMIUM SULPHIDE ACTIVATED BY MANGANESE AND GOLD.

J.P.Leroux and P.Thureau.
C.R. Acad. Sci. (Paris), Vol. 248, No. 24, 3424-6 (June 15, 1959).
In French.

The emission of the phosphor under ultraviolet excitation changes reversibly from yellow-green at 20° C to orange-red at 210° C. The output at 5220 and 5900 A, measured through narrow pass interference filters, gives a ratio varying widely and reproducibly with temperature, which may thus be determined from a calibration curve. A much smaller change of the ratio occurs with intensity of excitation. S.T.Henderson

THERMODYNAMICS

536.7

1063 THERMODYNAMICS OF AN IRREVERSIBLE QUASI-STATIC PROCESS.

J.S Thomsen.
Amer. J. Phys., Vol. 28, No. 2, 119-22 (Feb., 1960).

Quasi-static processes are not reversible when sliding friction forces are present. An example is considered consisting of a cylinder containing a gas and equipped with a piston for which sliding friction forces are significant. It is assumed that the frictional forces may be a function of temperature, displacement, and direction of motion. From measurements on the boundary of the system it is then possible to determine energy as a function of temperature and volume. However, force and entropy are not uniquely determined although thermodynamic considerations impose severe restrictions on the possible choice of these quantities. The generalized definition of entropy proposed by Bridgman is discussed in light of these conclusions. The possible analogy between this model and a perfectly plastic material is briefly discussed.

536.7

1064 METHOD FOR PREDICTING VAPOUR—LIQUID EQUILIBRIUM RELATIONSHIP IN MULTICOMPONENT SYSTEMS.

W.E.Ehrett, J.H.Weber and D.S.Hoffman.
Industr. engng Chem., Vol. 51, No. 5, 711-13 (May, 1959).

Generalized correlations of data for substances (benzene, n-butane, 1-butene, propene, methane, ethane) are developed for accurate and rapid estimation of standard-state liquid fugacity and ideal K values. W.Good

536.7

1065 CORRELATING LATENT HEATS AND ENTROPIES OF VAPORIZATION WITH TEMPERATURE.

D.F.Othmer and D.Zudkevitch.
Industr. engng Chem., Vol. 51, No. 6, 791-6 (June, 1959).

New equations and the construction of nomograms (one for latent heat and one for entropy of vaporization) are adduced from the Clapeyron equation relating latent heat, vapour pressure, and temperature. Reference substance plots and thermodynamic corrections for non-ideal gas behaviour and liquid compressibility enable accurate values to be determined over wide temperature and pressure ranges. W.Good

536.7

1066 THE LOW TEMPERATURE HEAT CAPACITY AND ENTROPY OF THALLOUS CHLORIDE.

I.R.Bartky and W.F.Giauque.
J. Amer. Chem. Soc., Vol. 81, No. 16, 4169-72 (Aug. 20, 1959).

The heat capacity of thallous chloride has been measured from 15 to 310° K. The entropy at 298.15° K was found to be 26.59 cal deg^{-1} $mole^{-1}$. The heat capacity, entropy, $(F^0 - H_0^0)/T$ and $(H^0 - H_0^0)/T$ functions for TlCl are tabulated from 15 to 300° K. The entropy change calculated from the third law of thermodynamics for the cell reaction Tl + AgCl = TlCl + Ag was found to be in good agreement with the cell temperature coefficients of Gerke provided the entropy change for the step Tl(s) = Tl(amalg) is calculated from $\Delta S = (\Delta H_{calorimetric} + FE)/T$ rather than from dE/dT. It is evidently difficult to obtain reliable cell temperature coefficients involving a metal electrode even when it is as soft as thallium. Third law results have been used to calculate these heats of reaction at 298.15° K: Tl(cryst.) + AgCl = TlCl + Ag, $\Delta H^0 = -18\,430$ cal $mole^{-1}$; Tl + $\frac{1}{2}Cl_2$ = TlCl, $\Delta H^0 = -48\,800$ cal $mole^{-1}$.

LOW-TEMPERATURE PHYSICS

536.48

1067 THERMAL CONTACT BELOW 1° K.

H.R.Hart, Jr and J.C.Wheatley.
Bull. Inst. Internat. Froid, Annexe 1958-1, 311-16.

The heat transfer of crystals glued to quartz with Ge-7031-toluene (Abstr. 4277 of 1957) is measured between 0.05° K and 0.3° K. The results can be represented by

$$Q = \alpha(T_{hot}^n - T_{cold}^n)$$

with n = 3.7 and $\alpha = 2.5 \times 10^4$ erg. sec^{-1} cm^2 $(deg\ K)^{3.7}$ for iron ammonium alum, and with n = 3.4, $\alpha = 4.5 \times 10^3$ erg. sec^{-1} cm^2 $(deg\ K)^{3.4}$ for cerium magnesium nitrate. Subsequent experiments in the same temperature range using the same bonding techniques indicated that the predominant resistance to heat transfer in the above experiments was the thermal diffusivity of the crystals rather than the bond resistance. H.London

536.48

1068 NUCLEAR SPIN RELAXATION IN LIQUID He^3.

R.H.Romer.
Phys. Rev., Vol. 115, No. 6, 1415-16 (Sept. 15, 1959).

The nuclear spin thermal relaxation time, T_1, of He^3 nuclei was measured between 1.2° and 3.0° K in pure liquid He^3 under its saturated vapour pressure. The measured times are those characteristic of the bulk liquid. T_1 is 300 sec at 1.2° and increases to 550 sec at 3.0°. These results are in fair agreement with the theory of Bloembergen, Purcell and Pound (Abstr. 2529 of 1948). For a 12% solution of He^3 in He^4 under its saturated vapour pressure, T_1 is about 2000 sec and does not show any sharp change at the lambda point. In pure He^3 gas at 4.2° K and 1000 mm pressure, T_1 is at least 1000 sec. In dilute solutions at 1.25° K, T_1 is at least 90 min for a 3.5% solution and at least 120 min for a 1.7% solution.

536.48 : 539.2

1069 SELF-DIFFUSION AND NUCLEAR RELAXATION IN He^3.

R.L.Garwin and H.A.Reich.
Phys. Rev., Vol. 115, No. 6, 1478-92 (Sept. 15, 1959).

Direct spin-echo measurements of diffusion coefficient (D) and spin relaxation time (T_1 and T_2) were performed on He^3, with an accuracy ~2% in the range 0.5° to 4.2° K and at pressures to 67 atm in the liquid, the solid, and in dilute solutions of He^3 in He^4. Unactivated diffusion is observed to the lowest temperatures in the liquid, but not in the solid. By measurement of D at 19 atm an activation energy of 13.7° K was found for the production of scatterers in He II. Experimental details are fully discussed.

536.48 : 539.18

MASS TRANSPORT IN HELIUM ISOTOPES SEPARATION.

See Abstr. 471

536.48

1070 EXPERIMENTS ON THE HYDRODYNAMIC STABILITY OF HELIUM II BETWEEN ROTATING CYLINDERS.

R.J.Donnelly.
Phys. Rev. Letters, Vol. 3, No. 11, 507-8 (Dec. 1, 1959).

It is found that the apparent viscosity rises in two distinct steps as the speed of rotation increases, presumably associated with the onset of instability in the superfluid and normal fluid respectively, as predicted theoretically (Abstr. 9139 of 1957).

536.48 : 530.16

THE SPECTRUM OF ELEMENTARY EXCITATIONS IN A NON-IDEAL BOSE GAS. See Abstr. 901

536.48

1071 SOUND EXCITATIONS IN FERMI SYSTEMS.

V.M.Galitskii.

Zh. eksper. teor. Fiz., Vol. 34, No. 4, 1011-13 (April, 1958). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 34(7), No. 4, 698-9 (Oct., 1958).

Belyaev (Abstr. 6650 of 1958) has given a Green's function method for studying phonon excitations in a low-temperature Bose gas with weak repulsions. In this letter, a similar method is applied to phonon excitations in the "Bose gas" of bound pairs of particles which is formed in a degenerate Fermi gas with weak attractions near absolute zero. O.Penrose

536.48

1072 SUPERCONDUCTIVITY: A SOLVED PROBLEM?

H.W.Lewis.

Science, Vol. 130, 599-601 (Sept. 11, 1959).

A general account of the subject in non-mathematical terms.

536.48

1073 THEORY OF SUPERCONDUCTIVITY.

L.N.Cooper.

Amer. J. Phys., Vol. 28, No. 2, 91-102 (Feb., 1960).

Some recent developments in the theory of superconductivity are discussed with emphasis on the underlying physical ideas. It is proposed that the electron—phonon interaction produces a strong preference for singlet zero momentum pairs in two-body correlations which can account for superconductivity and related phenomena.

536.48

1074 LAW OF CORRESPONDING STATES IN SUPERCONDUCTIVITY.

J.C.Swihart.

Phys. Rev., Vol. 116, No. 2, 346-7 (Oct. 15, 1959).

It is shown by means of a crude calculation that a refined version of the Bardeen—Cooper—Schrieffer theory of superconductivity in which the energy gap function $\mu(\nu)$ would not be approximated by a constant would give very nearly the same relation between H_0, the critical field at $T = 0$; $2\mu(0)$, the energy gap; and $N(0)$, the density of states at the Fermi surface. Agreement between the theory and experiment is found for the cases of Al, Sn, Hg, and Pb although the experimental error is large for Hg. For the case of Pb, this is the first agreement between the theory and experiment with regard to the thermodynamic variables.

536.48

1075 KNIGHT SHIFT IN SUPERCONDUCTORS.

R.A.Ferrell.

Phys. Rev. Letters, Vol. 3, No. 6, 262-5 (Sept. 15, 1959).

Using the theory of Townes et al. (Abstr. 5958 of 1950) to interpret the results of Reif (Abstr. 5353 of 1957) and of Androes and Knight (Abstr. 12500 of 1959), the values of the superconducting and normal susceptibilities are practically equal, even at absolute zero. This result is in disagreement with the theory of Bardeen et al. (Abstr. 1708 of 1958), but can be explained by a modification due to Heine and Pippard (Abstr. 1480 of 1959), which may however require a specific heat contribution from the spin excitations in disagreement with experiment. The present note proposes an alternative explanation which is free from these difficulties. It is shown that the Knight shift results from a normal magnetization cloud, which is closely bound to the nucleus and is the same in both the normal and superconducting states, and a diffuse compensating cloud which appears only in the superconducting state and is of very large linear dimensions. Since only a fraction of this cloud is contained in a small sample, the superconducting shift should be smaller than , but comparable to, the normal shift. The actual size of the decrease is $(\Delta H_n - \Delta H_s)/\Delta H_n \cong fL/\xi_0$, where L is the diameter of a sphere containing the nucleus, ξ_0 is the coherence length, and f is the number of times that the electrons giving rise to the magnetizing cloud are scattered before spin—orbit coupling flips their spin. (This applies only when L is less than ξ/f.) S.A.Ahern

536.48

1076 MEISSNER—OCHSENFELD EFFECT IN THE BOGOLJUBOV THEORY.

R.M.May and M.R.Schafroth.

Phys. Rev., Vol.115, No. 6, 1446-59 (Sept. 15, 1959).

The magnetic response to the Bogolyubov superconductivity model is calculated by employing a new technique for dealing with gauge-noncovariant approximations to gauge-covariant Hamiltonians. By extending this treatment to very high orders of perturbation theory, the authors derive a Meissner—Ochsenfeld effect with infinite correlation length, as anticipated by London. For larger wavelengths, the response differs from the London one, in the way predicted by Pippard.

536.48

1077 ISOTOPE EFFECT IN THE BARDEEN—COOPER—SCHRIEFFER AND BOGOLIUBOV THEORIES OF SUPERCONDUCTIVITY.

J.C.Swihart.

Phys. Rev., Vol. 116, No. 1, 45-52 (Oct. 1, 1959).

It is shown that the Bardeen—Cooper—Schrieffer and Bogoliubov theories of superconductivity predict an isotope effect which is the same for all superconductors, so long as the Coulomb interaction is neglected. This is demonstrated by writing the system of integral equations in a mass-invariant form, and it does not involve finding actual solutions. The theories predict that H_0, T_c, and the energy gap at $T = 0$ are proportional to $M^{-1/2}$. The inclusion of the Coulomb interaction destroys the invariance of the equations and introduces deviations from the $-\frac{1}{2}$ in the exponent. The magnitude of the deviation depends on the particular superconductor considered.

536.48

1078 THEORY OF NUCLEAR SPIN RELAXATION IN SUPERCONDUCTORS.

L.C.Hebel.

Phys. Rev., Vol. 116, No. 1, 79-81 (Oct. 1, 1959).

Using analytical methods, a new evaluation was made of R_s/R_n, the ratio of nuclear spin—lattice relaxation rate in the superconducting phase to that in the normal phase, from expressions previously derived by Hebel and Slichter (Abstr. 7006 of 1959) using the Bardeen—Cooper—Schrieffer theory of superconductivity. The results are given for several values of the effective breadth of the Bardeen—Cooper—Schrieffer energy levels.

536.48

1079 FERROMAGNETIC SOLUTES IN SUPERCONDUCTORS.

B.Matthias, V.B.Compton, H.Suhl and E.Corenzwit.

Phys. Rev., Vol. 115, No. 6, 1597-8 (Sept, 15, 1959).

Solid solutions of Cr, Mn, Fe, or Co in Ti raise its superconducting transition temperature by almost an order of magnitude. At very small concentrations this is much more than could be expected from a variation of electron concentration.

536.48

1080 FREQUENCY DEPENDENCE OF THE SURFACE RESISTANCE OF SUPERCONDUCTING TIN IN THE MILLIMETER WAVELENGTH REGION.

R.Kaplan, A.H.Nethercot, Jr and H.A.Boorse.

Phys. Rev., Vol. 116, No. 2, 270-9 (Oct. 15, 1959).

The ratio of the superconducting to normal surface resistance of polycrystalline tin was measured at seven frequencies between 17 and 77 kMc/s and at temperatures from 1.5° to 3.0°K. These data plus those of other investigators have been compared with the predictions of two theories: the first a calculation made by Serber (unpublished) based on the London two-fluid model of superconductivity and the Reuter—Sondheimer theory of the anomalous skin effect, and the second a calculation based on the Bardeen—Cooper—Schrieffer theory as developed by Bardeen and Mattis. Agreement between experimental and theoretical results is only fair in the case of the two-fluid theory. The best values of the relevant parameters, Fermi velocity v and mean free path l, were found to be, respectively, $(1.25 \pm 0.3) \times 10^7$ cm/sec and $10^{-3} \rightarrow 10^{-1}$ cm. A value of v of approximately 10^8 cm/sec would be expected for tin. The surface resistance ratio from the Bardeen—Cooper—Schrieffer theory was calculated only for the extreme anomalous limit and the calculation therefore should not apply too accurately for tin. However, a curve of the right general shape is obtained and further calculations more appropriate to tin should improve the agreement between theory and experiment.

536.48

1081 CURRENT TRANSITIONS IN SUPERCONDUCTIVE TIN FILMS.

J.W.Bremer and V.L.Newhouse.

Phys. Rev., Vol. 116, No. 2, 309-13 (Oct. 15, 1959).

Except at temperatures just below the critical temperature the change of resistance of a superconducting film if the current through it is increased slowly takes place by a discontinuous transition, exhibits hysteresis, and is dominated by Joule heating effects. By applying current in short pulses, it has been possible to obtain isothermal transitions in films deposited on a flat surface. These transitions are smooth, do not exhibit hysteresis, and have a shape independent of film resistance. The critical current I in films of thickness about twice the penetration depth is proportional to film width and can be related to the critical field of the film H_C, and the bulk critical field H_{CB}, by the relation I H_C = const H_{CB}^2. It is also shown that by calculating the conditions of thermal equilibrium the d.c. transition curves with Joule heating can be derived from the isothermal transition results.

536.48

1082 TIME DELAYS IN THE SUPERCONDUCTING TRANSITION OF LEAD FILMS. R.F.Broom and E.H.Rhoderick.
Phys. Rev., Vol. 116, No. 2, 344-5 (Oct. 15, 1959).

Strips of lead between 500 and 1000 A thick, evaporated onto mica substrates, were driven from the superconducting into the normal state by rectangular current pulses of 0.4 μsec duration. For current amplitudes just above the threshold value, there was an apparent delay of up to 0.4 μsec before resistance began to appear in the strip. A plausible explanation is that a minute portion of the strip in the neighbourhood of a flaw is driven normal almost instantaneously, and that the Joule heating of this normal region eventually causes thermal propagation of the interphase boundary. The delay is the time that must elapse before the temperature of the nucleus rises sufficiently to initiate the thermal spreading process. Similar results were obtained with lead—indium alloys, but in the case of tin the delay was less than the instrumental resolution. The relevance of these results to the interpretation of d.c. critical currents is discussed.

536.48

1083 APPARENT STRUCTURE ON THE FAR INFRARED ENERGY GAP IN SUPERCONDUCTING LEAD AND MERCURY. D.M.Ginsberg, P.L.Richards and M.Tinkham.
Phys. Rev. Letters, Vol. 3, No. 7, 337-8 (Oct. 1, 1959).

A preliminary account is given of the results of far infrared absorption studies on superconducting lead and mercury at about 1.5°K, using both reflection and transmission techniques. Consistent irregularities in the absorption-frequency curves are ascribed either to anisotropy of the energy-gap or to collective excited states with energies below the top of the expected gap.

L.Mackinnon

536.48

1084 LOW TEMPERATURE RESISTIVITY OF PLUTONIUM AND NEPTUNIUM.
J.A.Lee, G.T.Meaden and K.Mendelssohn.
Proc. Phys. Soc., Vol. 74, Pt 5, 671 (Nov., 1959).

Preliminary note of measurements at 0.75°K.

536.48 : 538.56

LIQUID HELIUM CRYOSTAT WITH AN INTEGRAL SUPERCONDUCTING RESONATOR. See Abstr. 295

536.48

1085 He^3—He^4 THERMAL RECTIFIERS.
R.L.Garwin and H.A.Reich.
Bull. Inst. Internat. Froid, Annexe 1958-1, 83-9.

Simple devices giving unidirectional passage of heat have been built which utilize the heat flow properties of He^3—He^4 solutions. By paying special attention to the Kapitza boundary resistance it was possible to make heat rectifiers which have at ~ 1.5°K a forward resistance of 1° per watt and a reverse resistance 10^4 times as large. At higher temperatures these devices depend on a difference in the geometry at the two ends: an additional volume provided at one end allows the He^3, which is driven to this end by the heat flush effect, to hide out of the path of heat. If it is driven to the other end it blocks the flow of heat. At lower temperatures use is made of gravitational convection which prevents the accumulation of He^3 if it is driven downwards. These rectifiers have not yet been used below 1° but have proved useful at the high temperature end of cyclic adiabatic-demagnetization refrigerators.

H.London

536.48

1086 A NEW ABSOLUTE NOISE THERMOMETER AT LOW TEMPERATURES. H.J.Fink.
Canad. J. Phys., Vol. 37, No. 12, 1397-406 (Dec., 1959).

If three resistors, which are kept at different temperatures, are arranged in form of a π network and if two of the thermal noise voltages appearing across the π network are multiplied together and averaged with respect to time, then under certain conditions the correlation between those voltages can be made zero. This condition is used to calculate the temperature of one noise source provided all the resistance values and the other temperatures are known. A noise thermometer of this kind was constructed which is capable of measuring temperatures below approximately 140°K. The boiling points of liquid oxygen and liquid nitrogen were determined absolutely within 0.2%. Between 1.3°K and 4.2°K the thermometer had to be calibrated due to errors arising in the equipment and the measured temperatures were then accurate within ±1%.

536.48

1087 COOLING BY ADIABATIC MAGNETIZATION.
W.P.Wolf.
Phys. Rev., Vol. 115, No. 5, 1196-7 (Sept. 1, 1959).

A new method of producing temperatures below 1°K is considered. It utilizes the fact that the entropy of certain paramagnetic salts is increased by the isothermal application of a magnetic field, so that, conversely, adiabatic magnetization should produce cooling. The factors limiting the temperatures which can be reached are discussed, and some suitable classes of salts proposed.

ELECTRICITY
ELECTRICAL MEASUREMENTS

537.7

1088 EDDY-CURRENT METHOD FOR MEASURING THE RESISTIVITY OF METALS.
C.P.Bean, R.W.DeBlois and L.B.Nesbitt.
J. appl. Phys., Vol. 30, No. 12, 1976-80 (Dec., 1959).

A method for measuring the resistivity of metallic specimens is described. The measurement is made by noting the rate of decay of flux from a bar situated in an external magnetic field that has been rapidly reduced to zero. The method is suitable for specimens greater than 5×10^{-3} cm in diameter. For a specimen 1 cm in diameter, resistivities from 10^{-11} to 10^{-3} ohm cm may be measured with an error of less than three percent. The method requires no contact to the specimen, and local values of resistivity may be measured. Several applications are described.

537.7 : 621.395.625.2

1089 THERMOPLASTIC RECORDING.
W.E.Glenn.
J. appl. Phys., Vol. 30, No. 12, 1870-5 (Dec., 1959).

A new method is described for recording electrical signals. Information is written at extremely high density by means of an electron beam on a film consisting of a low melting thermoplastic material. This can be projected as a full colour image, or can be converted to an electrical signal. The tape, which is processed by quick heating, can be readily erased and re-used.

ELECTROSTATICS . DIELECTRICS

(The study of solids through their dielectric properties is included under Solid-State Physics; similarly for Liquid State and Gaseous State)

537.2

1090 GRAPHICAL REPRESENTATION OF SOME ELECTRICAL POTENTIAL FIELDS. R.L.Heid.
Amer. J. Phys., Vol. 28, No. 2, 112-14 (Feb., 1960).

Electric potential fields were plotted by means of field mapping paper and probes. The paper was cut into different patterns simulating various electrical circuits. The results illustrate the potential distributions in these circuits.

537.2 : 538.2

PROJECTIONS OF DIPOLE FLUX PATTERNS. See Abstr. 286

537.2

1091 RELAXATION THEORY OF ELECTRIC POLARIZATION.
N.S.Fastov and B.N.Finkel'shtein.
Izv. Akad. Nauk SSSR, Ser. fiz., Vol. 22, No. 3, 249-51 (1958).
In Russian. English summary: PB 141041T-3, obtainable from Office of Technical Services, U.S. Dept. of Commerce, Washington, D.C., U.S.A.

A state of thermodynamic equilibrium can be assumed if quasi-steady field quantities are concerned, but if the field changes with finite velocity, deviations from thermodynamic equilibrium occur in the polarized body. These deviations can be represented by a vector ξ_j and the free energy of the body per unit volume is then:

$$F = F_0 + \tfrac{1}{2}a_1D_j^2 + a_2D_j\xi_j + \tfrac{1}{2}a_3\xi_j^2,$$

where F_0 is the free energy of the dielectric in the absence of field, D_j the voltage vector of induction and and a_1, a_2, a_3 are material constants, and are essentially positive. Expressions for the frequency of maximum absorption and the corresponding loss angle are also derived. J.H.Mason

CURRENT ELECTRICITY
ELECTROKINETICS

(The study of solids through their electrical conduction properties is included under Solid-State Physics)

537.3 : 537.56

1092 THE INVERSE SKIN EFFECT.

M.G.Haines.

Proc. Phys. Soc., Vol. 74, Pt 5, 576-84 (Nov., 1959).

The axial current density in an infinite cylindrical conductor is calculated as a function of radius and time. In the problem studied the total axial current is specified as a function of time. The case of a rigid conductor is studied first, and the analysis is extended to the case of a radially expanding or contracting cylinder such as occurs in a linear pinched plasma. The radial velocity is assumed proportional to the radius, while the outside radius of the conductor is a general but specified function of time. It is shown that the variation of total current with time can give rise to distributions of current density which bear no resemblance to the normal skin effect. In fact, an inverse skin effect or even reversal of current may occur. This latter effect causes a reversed pinch force and perhaps eventual break-up near the surface of a plasma. Some special total current profiles are used to illustrate these features.

537.3 : 621.326.7

1093 ENERGY LOSS FROM THE FILAMENT OF AN INCANDESCENT LAMP.

J.W.Dewdney.

Amer. J. Phys., Vol. 28, No. 2, 89-91 (Feb., 1960).

The current–voltage characteristic of a light bulb can be analysed graphically to reveal much about heat loss from a hot filament. The low-temperature region is particularly interesting.

537.3

1094 ELEMENTARY ELECTRICITY EXPERIMENT INVOLVING MEASUREMENT AND SYNTHESIS.

W.R.Smith.

Amer. J. Phys., Vol. 28, No. 2, 144-6 (Feb., 1960).

An elementary experiment is described, designed to develop the student's feeling for circuit behaviour and introduces him to some nonlinear elements.

537.3 : 621.3.012.8

1095 CONDUCTING ANALOGS OF A MAGNETIC FIELD.

J.R.Barker.

Amer. J. Phys., Vol. 28, No. 2, 139-44 (Feb., 1960).

The distribution of electric current in a conducting medium has a close analogy with the distribution of magnetic flux in a geometrically similar magnetic field. There is a second form of the analogy, when the field is two-dimensional, in which the electric equipotentials correspond with the magnetic flux lines.

537.36 : 532.5

1096 ION DRAG PUMPS.

O.M.Stuetzer.

J. appl. Phys., Vol. 31, No. 1, 136-46 (Jan., 1960).

The behaviour and the efficiency of a simplified model of an ion drag pump for insulating fluids is discussed theoretically. Supporting measurements on real pumps are reported. Cascading and parelleling of pumping stages is investigated.

IONIZATION

537.56

1097 METHODS OF UNIPOLAR IONIZATION OF AIR BY MEANS OF AERO-IONIZERS.

Ya.Yu.Reinet,Kh.F.Tammet and L.O.Val't.

Radiotekhnika i Elektronika, Vol. 4, No. 8, 1335-8 (Aug., 1959). In Russian.

Briefly surveys recent work on this subject at Tartu State University. D.E.Brown

537.56 : 536.46

1098 ABSORPTION AND DISPERSION OF MICROWAVES IN FLAMES.

J.Schneider and F.W.Hofmann.

Phys. Rev., Vol. 116, No. 2, 244-9 (Oct. 15, 1959).

The dependence of the high-frequency electric conductivity and the optical constants of a weakly ionized gas on the microwave frequency, the electron–molecule collision frequency, the electron concentration, and an external magnetic field are discussed. Measurements of the electric conductivity between 23.10 and 92.96 kMc/s indicate that the effective electron–molecule collision frequency in an acetylene–air flame is independent of the electron velocity within the limits of error. Cyclotron resonance of free electrons was found in low-pressure flames at 24 kMc/s. This effect can be used to determine both the concentration of free electrons and the electron collision frequency.

537.56

1099 RELATIVISTIC INCREASE OF IONIZATION IN XENON.

A.Rousset, A.Lagarrigue, P.Musset, P.Rançon and X.Sauteron.

Nuovo Cimento, Vol. 14, No. 2, 365-75 (Oct. 16, 1959).

The relativistic increase of ionization was studied in various gaseous mixtures by the method of drop-counting in a cloud chamber. If ρ is the relative ionization of $x = \beta/\sqrt{1-\beta^2}$, it is found that, when $x = 300$, in pure xenon or mixtures of xenon and hydrogen, ρ is of the order of 1.7. On the other hand the value of ρ drops to 1.3 if helium is mixed with xenon.

537.56

1100 SPACE-CHARGE RETARDATION OF ELECTRON AVALANCHES.

K.J.Schmidt-Tiedemann.

Z. Naturforsch., Vol. 14a, No. 11, 989-94 (Nov., 1959).

The electric field generated by the positive and negative space charge of a single electron avalanche moving in a homogeneous electric field is calculated. Treating the interaction of the avalanche with its own space charge field as a first-order perturbation, a growth formula is obtained which differs markedly from the common Townsend formula. The theoretical results fit well with previously reported experimental data.

537.56

1101 IONISATION OF THE HYDROGEN ATOM BY SLOW ELECTRONS.

R.Peterkop.

Latv. PSR Zinat. Akad. Vestis., No.8 (145), 67-74 (1959). In Russian.

The problem is treated by the method of integral equations. The solutions are found and represented by graphs, and the approximations are discussed. P.Roman

537.56

1102 FORMATION OF NEGATIVE IONS IN CO BY ELECTRON CAPTURE FROM FAST HYDROGEN ATOMS.

T.M.Donahue and F.Hushfar.

Phys. Rev. Letters, Vol. 3, No. 10, 470-2 (Nov. 15, 1959).

An experimental curve of electron loss cross-section versus atom energy (up to about 40 keV) for H in CO is given. It is suggested that the observed peaks in the cross-section occur at energies such that the atomic electron may be captured by the target molecule, and values calculated for the energy at threshold of the electrons stripped from H, are found to be in close agreement with the appearance potentials of O^- and C^-. No peaks in the cross-sections were found for the case of H in A. J.Dutton

537.56

1103 THE MOBILITY OF POTASSIUM IONS IN NITROGEN AND NEON AT 294°K.

R.W.Crompton and M.T.Elford.

Proc. Phys. Soc., Vol. 14, Pt 5, 497-504 (Nov., 1959).

The mobility of potassium ions in nitrogen and neon has been measured by an electrical shutter method of the type developed by Bradbury and Nielsen (Abstr. 1794 of 1936) for measuring electronic drift velocities. The values obtained for the mobility μ_0, 2.54 and 7.42 $cm^2\ volt^{-1}\ sec^{-1}$ for nitrogen and neon respectively, are in good agreement with those listed by Tyndall [The Mobility of Positive Ions in Gases, London : Cambridge University Press (1938)]. The variation of the mobility with E/ρ_0 is shown to be in qualitative agreement with theoretical considerations while the disagreement between the present results and those of Mitchell and Ridler (Abstr. 5167 of 1934) is discussed.

ELECTRIC DISCHARGES

537.52

1104 ELEMENTARY DYNAMICS OF THE NONADIABATIC TRANSVERSE PINCH. B.D.Fried.

J. appl. Phys., Vol. 30, No. 11, 1778-83 (Nov., 1959).

The characteristics of the nonadiabatic transverse (E_θ,B_Z) pinch are studies for configurations in which the discharge tube, current coils, and condenser form an integral structure, allowing very high voltage gradients (10^5 to 10^6 V/cm). The dynamics of the first pinch contraction are analysed using the Garwin–Rosenbluth model of an infinitely conducting, collisionless plasma, and expressions are derived for the parameter values corresponding to maximum energy transfer to the gas for given energy per particle. Theoretical curves of pinch radius, current and plasma kinetic energy as functions of time for typical cases are shown, and the relative merits of this tranverse pinch and the more common longitudinal (E_Z,B_θ) pinch are discussed.

537.52

1105 PRE-DISCHARGE CURRENT PULSES AT REDUCED PRESSURE. L.A.Akol'zina.

Radiotekhnika i Elektronika, Vol. 4, No. 9, 1534-7. (Sept., 1959). In Russian.

Pre-discharge phenomena are investigated using audio frequencies of 50 c/s to 10 kc/s in short and long discharge spaces with external electrodes in argon, neon, helium and air, at pressures of 0.1 - 40 mm Hg. The experimental equipment is briefly described and various experimental curves are reproduced. D.E.Brown

537.52

1106 SPACE CHARGE PHENOMENA IN NITROBENZENE UNDER HIGH ELECTRIC FIELD.

P.Chong, C.Yamanaka and T.Suita.

J. Phys. Soc. Japan, Vol. 13, No. 7, 760-1 (July, 1958).

The Kerr electro-optical effect was used for studying the field distribution in nitrobenzene under both d.c. and single rectangular pulse voltages. It is shown that field enhancement takes place near the cathode. Assuming that movement of positive ions is responsible for field distortion, the mobility of the ions is estimated to be of the order of 10^{-3} cm^2 sec^{-1} V^{-1}. Z.Krasucki

537.52

1107 CONSTRICTED HIGH PRESSURE XENON DISCHARGES AT HIGH CURRENT DENSITIES.

A.Bauer and P.Schulz.

Z. Phys., Vol. 155, No. 5, 614-27 (1959). In German.

Describes measurements made on discharges (25-55 atm pressure) with a diameter of 1.5 mm, and running in quartz tubes. Probe measurements of potential gradients were made. Arc temperatures ($\sim$ 10 000° K) were estimated from observations made on conductivities and absolute light emission. J.D.Craggs

537.52

1108 THE FLIGHT OF MACROPARTICLES OF A SUBSTANCE ON DISRUPTIVE DISCHARGE IN VACUO.

N.B.Rozanova and M.V.Kozlova.

Radiotekhnika i Elektronika, Vol. 4, No. 8, 1267-73 (Sept., 1959). In Russian.

Describes the experimental vacuum tube with nickel, tungsten, or graphite electrodes and applied voltages of 50-100 kV. It was established that the luminous tracks commonly observed on disruptive discharge in vacuo are due to the flight of incandescent macroparticles with dimensions up to 10^{-2} cm breaking off from the electrodes (principally the cathode). The velocity of the particles is of the order 10^3 cm sec^{-1}, the normal acceleration 10^2-10^4 g, and the charge 10^1 CGSE. D.E.Brown

537.52 : 536.7 : 538.56

1109 POSSIBILITY OF PRODUCTION OF NEGATIVE TEMPERATURE IN GAS DISCHARGES. A.Javan.

Phys. Rev. Letters, Vol. 3, No. 2, 87-9 (July 15, 1959).

One may expect that under favourable conditions the excitation of atomic levels by electrons in a discharge can lead, in principle, to a state of negative temperature. However, severe restrictions exist if densities of the excited atoms as large as those needed for maser action are required. The author considers these limitations and certain types of systems which appear to be most favourable for practical application of this proposal. J.M.Baker

537.52 : 621.316.57

1110 INVESTIGATIONS ON ARCS IN NEW TYPES OF QUENCHING CHAMBERS FOR RAPID D.C. SWITCHING.

F.Wegmann.

Electrotech. Z (E.T.Z.) A, Vol. 80, No. 10, 289-95 (May 11, 1959). In German.

A discussion of various quenching devices (multiple diaphragm chambers etc.) for arc discharges. In some cases magnetic forces are of importance. Diagrams of various quenching chambers are shown and there are data on the effect of various external conditions on the arc voltage gradient etc. J.D.Craggs

537.52 : 621.387

1111 CHECKING THE APPLICABILITY OF THE PROBE METHOD TO THE MEASUREMENT OF THE CHARGE CONCENTRATION IN A HIGH-FREQUENCY DISCHARGE.

S.M.Levitskii and I.P.Shashurin.

Radiotekhnika i Elektronika, Vol. 4, No. 8, 1238-43 (Aug., 1959). In Russian.

Describes comparative measurements of electron concentrations in d.c. or r.f. discharges (frequency 0.7 to 68 Mc/s) by using single probe, double probe, and cavity resonator methods. Assuming that the resonator method yields the true figures, it can be concluded that the single probe method is suitable for h.f. discharge measurements, whilst the double probe method should only be used when special factors make the single probe method impracticable. D.E.Brown

537.52 : 621.387

1112 FEATURES OF ELECTRON OSCILLATION DISCHARGES IN A MAGNETIC FIELD.

E.T.Kucherenko and O.K.Nazarenko.

Radiotekhnika i Elektronika, Vol. 4, No. 8, 1253-6 (Aug., 1959). In Russian.

Establishes the existence of two discharge states on varying the magnetic field. The first state is excited with H_2 pressures $< 2 \times 10^{-3}$ mm Hg and fields $\sim$ 50 Oe. The second (arc) state is excited at H_2 pressures $> 2 \times 10^{-3}$ mm Hg and fields from a few hundred to $\sim$ 1000 Oe. The work is of a preliminary nature. D.E.Brown

537.52

1113 MOTION OF HIGH SPEED ARC SPOTS IN MAGNETIC FIELDS. D.Zei and J.G.Winans.

J. appl. Phys., Vol. 30, No. 11, 1813-19 (Nov., 1959).

Retrograde motion of mercury arc spots when in a groove in the cathode above the level of mercury was compared with motion of spots at the junction of mercury and the molybdenum cathode. A rapid rise in retrograde velocity occurs at about 10 000 Oe for junction motion but at less than 5000 Oe for groove motion. Spectra show more multiply charged ions for groove than for junction motion for the same magnetic field strength. The velocity for groove motion always exceeds the velocity for junction motion, and it increases markedly with a reduction in mercury vapour pressure. For groove motion increasing current causes the retrograde velocity to pass through a maximum. Observations are described by the mechanism proposed by St. John and Winans (Abstr. 7473 of 1954, 7079 of 1955).

537.52

1114 AN EFFECT OF OXIDE LAYERS ON THE BEHAVIOUR OF VACUUM ARC CATHODE SPOTS.

H.Wroe and R.H.Alderson.

Nature (London), Vol.183, 1544 (May 30, 1959).

A phenomenon is described observed during a study on the effect of surface condition on the behaviour of the cathode spot of a d.c. vacuum arc. An etched and oxidized vacuum-cast copper cathode was attacked by the cathode spot for 20 msec. The cathode spot was found to operate more easily on some grains than on others, and the track of the cathode spots stopped abruptly at the grain boundaries. No explanation is given for this phenomenon. R.Neumann

537.52

1115 STUDIES OF COLD CATHODE DISCHARGES IN MAGNETIC FIELDS. J.Backus.

J. appl. Phys., Vol. 30, No. 12, 1866-9 (Dec., 1959).

Some experimental studies of a cold cathode discharge in a strong magnetic field are described. Current densities of the order of half an ampere per square centimeter in various gases were used. For such a discharge, the current to the cathodes is about 75% ionic. Positive ions leaving the discharge by moving across the magnetic field were observed with a mass spectrometer and showed a temperature of about 1 V. Fast electrons from the cathode escape from the discharge across the magnetic field without losing the greater part of their energy. By considering the rate of ion production it is shown that the slow electrons in the discharge have a temperature less than about three volts. Fluctuations in charge densities must play a very important role in the mechanism of the discharge.

537.52

1116 THE DEPENDENCE OF POINT-DISCHARGE CURRENTS ON WIND AS EXAMINED BY A NEW EXPERIMENTAL APPROACH. M.I.Large and E.T.Pierce.

J. atmos. terrest. Phys., Vol. 10, No. 5-6, 251-7 (1957).

Experiments are described in which a metal point mounted in the open air is artificially raised to a high potential V and the resulting point-discharge current I is measured. The relation

$$I = A(V - V_0)(W^2 + c^2V^2)^{\frac{1}{2}}$$

where A and c are constants, W the wind speed, and V_0 the onset potential, is found to fit the results reasonably well. It is shown that all point-discharge experiments may be interpreted in terms of the rapidity with which the ambient space-charge is removed; this removal may be by the wind or by the ion velocity in the surrounding field, and the relative importance of the two factors will vary from experiment. Finally, some remarks on the alti-electrograph results are appended.

537.52

1117 POINT DISCHARGE FROM AN ISOLATED POINT. J.R.Kirkman and J.A.Chalmers.

J. atmos. terrest. Phys., Vol. 10, No. 5-6 258-65 (1957).

The point-discharge current I from an isolated point at 27 m and 34 m height was measured and related to the wind-speed W and the potential gradient F at the ground at 47 m to windward, and also to the output of an agrimeter 7 m below the point. The results were related by $I = K(W + c)(F - M)$, and it shown that a formula of a similar type also fits earlier results which had previously been thought to obey a square law for I against F.

537.52

1118 THE BEHAVIOUR OF A TOWNSEND DISCHARGE IN A PLANE ELECTRODE SPARK GAP AT CONSTANT VOLTAGE. J.Büser.

Naturwissenschaften, Vol. 46, No. 21, 595 (1959). In German.

A very brief summary of a theoretical investigation of the current build up in a Townsend discharge. J.D.Craggs

537.52

1119 DISCHARGE FIRING IN INHOMOGENEOUS FIELDS AT LOW GAS PRESSURES. L.G.Guseva.

Radiotekhnika i Elektronika, Vol.4, No.8, 1260-6 (Aug., 1959). In Russian.

Describes experimental work showing that the firing of discharges in inhomogeneous fields on the left branch of the Paschen curve changes considerably on altering the electrode polarity. The firing voltage is in general higher than the voltage corresponding to the longest line of the field between the electrodes. An explanation is offered on the basis of an analysis of the different natures of ion and electron mobilities in rarified gases. D.E.Brown

537.52 : 539.19

DISSOCIATION PROCESSES IN BENZENE AND BENZENE DERIVATIVES IN A GLOW DISCHARGE. See Abstr. 485

537.52

1120 THE THERMALLY-INHOMOGENEOUS GLOW COLUMN. J.Wilhelm.

Naturwissenschaften, Vol. 46, No. 15, 471 (1959). In German.

A brief discussion of the solution of the differential equations for the radial distribution of temperature and carrier density in a thermally inhomogeneous glow column, including numerical computations for glow discharges in A. J.Dutton

537.52

1121 THE PRODUCTION OF THE JOSHI EFFECT IN THE INFRARED. M.Venugopalan.

Naturwissenschaften, Vol. 46, No. 19, 553 (1959).

Briefly describes certain experiments on the Joshi effect (corona current changes due to external irradiation) in chlorine with i.r. illumination. The current changes are briefly discussed. J.D.Craggs

537.52

1122 ON TWO FORMS OF THE BUSHEL DISCHARGE ORIGINATING IN THE BREAKDOWN OF POSITIVE POINT CORONA IN ATMOSPHERIC AIR. G.List.

Exper. Tech. der Phys., Vol. 6, No. 5, 223-8 (1958). In German.

Describes a photographic study of the "bushel" form of positive corona in air showing various phases of development. Breakdown voltage—gap spacing characteristics (point-plane geometry) and several photographs are included. J.D.Craggs

537.52 : 539.18

1123 ON THE EXTREME SHORTWAVE U.V.-LIGHT FROM A CYLINDRICALLY SYMMETRICAL RARE GAS CORONA. I. INTENSITY, ABSORPTION AND IONISATION IN CERTAIN GASES. W.Bemerl and H.Fetz.

Z. Phys., Vol. 135, No. 4, 458-67 (1959). In German.

Continuing earlier work (see Abstr. 4130 of 1956) measurements were made with He, Ne and A, with and without impurities. The intensity of radiation was measured with an internal copper photocathode; movement of this within the gas measured the absorption of radiation by the gas. A LiF filter was used to indicate the wavelength distribution of the radiation. Ionization produced by the radiation was measured. For He at low pressures, the radiation was largely absorbed and ionizing. The intensity of non-ionizing radiation increased with increasing pressure; this tallies with the visible spectrum which at low pressures includes lines of He^+ and at higher pressure is due to He and He_2. G.F.Lothian

537.52 : 539.18

1124 ON THE EXTREME SHORTWAVE U.V.-LIGHT FROM A CYLINDRICALLY SYMMETRICAL RARE GAS CORONA. II. THE TIME DELAY OF EMISSION. W.Bemerl and H.Fetz.

Z. Phys., Vol. 153, No. 4, 468-83 (1959). In German.

For Pt I see preceding abstract. After cessation of the discharge, the u.v. radiation and the visible bands decay exponentially with half-life $\Gamma = 10^{-6}$-10^{-4} secs; atomic lines in the visible decay much more rapidly. With increasing pressures, Γ passes through a maximum. The phenomena are explained as atoms in metastable states (a) diffusing to the walls and (b) undergoing 2- and 3-body collisions to produce He_2^* etc. The discharge tube and accessory apparatus to produce the decay curves on a c.r.o. are described. G.F.Lothian

PLASMA

537.56

1125 A DESCRIPTION OF AN ARRANGEMENT FOR THE GENERATION OF AN ARGON PLASMA STREAM WITH STABLE ELECTRODES AND THE MEASUREMENT OF THE TEMPERATURE DISTRIBUTION IN THE PLASMA STREAM. W.Neumann, A.Peters, K.Rademacher and R.Rompe.

Exper. Tech. der Phys., Vol. 7, No. 2, 77-84 (1959). In German.

Describes, with detailed diagram a source for a "plasma stream". The discharge (500A) passes between a cylindrical tungsten cathode and a water cooled copper ring anode. The maximum temperature in the plasma stream was about 15000°K. Temperature measurements were made from observations of the electron—ion collision continuum. J.D.Craggs

537.56

1126 THERMAL AND ELECTRICAL PROPERTIES OF AN ARGON PLASMA. H.N.Olsen.

Phys. of Fluids, Vol. 2, No. 6, 614-23 (Nov.-Dec., 1959).

Temperatures ranging from 10 000 to 25 000° K were measured spectroscopically in thermal plasmas of atmospheric pressure argon arcs at currents in the range of 200 to 800 A. Electrical properties of the plasmas were derived from measured radial temperature distributions using Spitzer's theory (Abstr. 3231 of 1953) for the temperature dependence of electrical conductivity of a completely ionized gas. Existence of local thermal equilibrium was demonstrated by the agreement between excitation temperatures determined from both atomic and ionic spectral line intensities. Agreement between values of electrical quantities obtained by direct measurement and those derived from measured temperatures based on the assumption of thermal equilibrium demonstrates the internal consistency of the experimental and analytical methods.

537.56

1127 CALCULATION OF THE THERMAL CONDUCTIVITY OF AN IONIC CURRENT. H.Cabannes.

C.R. Acad. Sci. (Paris), Vol. 249, No. 1, 47-9 (July 6, 1959). In French.

The conductivity tensor is calculated for a plasma and interpreted in terms of a central force inversely proportional to the fifth power of separation. C.G.Morgan

537.56

1128 THE DIFFUSION OF ELECTRONS IN A MAGNETIC FIELD. A.V.Zharinov.

Atomnaya Energiya, Vol.7, No.3, 220-4 (1959). In Russian.

Experimental data concerning the anomalously high mobility of electrons across a magnetic field are discussed. It is shown that the concentration distribution of the secondary plasma of a hot-cathode discharge is almost independent of the transverse diffusion coefficient of the electrons, and so cannot be used to elucidate the mechanism of diffusion. The electron diffusion coefficient is estimated from the density of the electron current to the anode, and the result confirms that the transverse mobility is anomalously high. J.B.Sykes

537.56 : 538.56

E.M. WAVE PROPAGATION IN PLASMA. See Abstr. 303

537.56

1129 ELECTROMOTIVE FORCE IN A HIGHLY IONIZED PLASMA MOVING ACROSS A MAGNETIC FIELD.

M.Sakuntala, B.E.Clotfelter, W.B.Edwards and R.G.Fowler.
J. appl. Phys., Vol. 30, No. 11, 1669-71 (Nov., 1959).

When a cloud of highly ionized gas flows across a magnetic field, an e.m.f. is produced in the gas which is proportional to the speed of flow. Oscillographic probe measurements have been carried out giving the flow speed as a function of position. By drawing currents from the probes the plasma resistance can be found at various distances from the plasma generator. The resistance is shown to be due to the motion of positive ions.

537.56

1130 EFFECT OF A CONTINUOUS ELECTRIC FIELD ON A PLASMA: ESTABLISHMENT OF THE EQUATION GIVING THE DISTRIBUTION FUNCTION.

A.Brin, J.-L.Delcroix and Y.Ozias.
C.R. Acad. Sci. (Paris), Vol. 249, No. 13, 1093-5 (Sept. 28, 1959). In French.

Application of Rosenbluth's general theory shows that no error results from the assumption of Spitzer et al. (Abstr. 1059 of 1951; 3231 of 1953) that the diffusion coefficients of particles in velocity space, used in the Fokker—Planck equation, are the same as those for the case of no applied field. B.Meltzer

537.56

1131 THE ROLE OF THE RADIATION OF IMPURITIES IN THE ENERGY BALANCE OF A PLASMA COLUMN.

V.I.Kogan.
Dokl. Akad. Nauk SSSR, Vol. 128, No. 4, 702-5 (1959). In Russian.

Figures given by Knorr (Abstr. 5837 of 1959) are used to estimate the effect of radiative energy loss from impurity ions in a steady-state pinched hydrogen plasma cooled by radiation and heated by Joule heating. Oxygen and calcium are taken as typical impurities, and free—free, free—bound, and bound—bound transitions are all allowed for. The condition for the impurity effect to be negligible is that the number of impurity ions per unit length should be much less than a certain critical value. This critical value is almost independent of temperature in the temperature range 10 to 10^4 eV; for low concentrations it is 10^{16} cm^{-1} for oxygen and 10^{15} cm^{-1} for calcium, and for higher concentrations it increases by a factor comparable with the charge on the impurity ion. The validity of the assumption of a steady state and the generalization of these results to other ion types are discussed. O.Penrose

537.56

1132 SPACE CHARGE WAVES IN CYLINDRICAL PLASMA COLUMNS. A.W.Trivelpiece and R.W.Gould.

J. appl. Phys., Vol. 30, No. 11, 1784-93 (Nov., 1959).

When a plasma is of finite transverse cross-section, space-charge waves may propagate even in the absence of a drift motion or thermal velocities of the plasma. Some of the properties of these space-charge waves have been investigated by regarding the plasma as a dielectric and solving the resulting field equations. The effect of a steady axial magnetic field is considered, but motion of heavy ions and electron temperature effects are neglected. Waves are found to exist at frequencies low compared with the plasma frequency as well as waves with oppositely directed phase and group velocities (backward waves). Many of the features of these waves have been verified experimentally by measuring phase velocity and attenuation of waves along the positive column of a low pressure mercury arc in an axial magnetic field. Measurements of electron density have been made using these waves and the results are compared with those obtained by other methods. A feature of these measurements is that they can be made with frequencies which are small compared with the plasma frequency.

537.56

1133 PROPAGATION CHARACTERISTICS OF DETONATION-GENERATED PLASMAS.

M.A.Cook, R.T.Keyes and L.L Udy.
J. appl. Phys., Vol. 30, No. 12, 1881-92 (Dec., 1959).

Studies are presented showing the electrical properties of the highly ionized, detonation-generated plasmas ejected into various gaseous media at the bare surfaces of high explosives. These external plasmas are shown to originate from chemionization in the reactions of high explosive at free surfaces and are not produced by thermal ionization in the shock wave propagated in the surrounding gaseous medium. The initial external-plasma length L_p* was found to be directly proportional to the length a_0 of the reaction zone of the high explosive-generating source. Conduction measurements in plasmas propagating in chlorine, oxygen, argon, nitrogen, helium and air showed that the electron affinity of the gaseous medium is important in determining the rate of decay of the plasma and its ultimate disintegration. The lifetime of external plasmas are substantial in media of low electron affinity, exceeding appreciably 250 μsec in such media as argon, helium, and nitrogen. Free electrons contribute practically the entire conductivity of these plasmas. Interesting pulsations occur when the external plasmas are generated by a charge of diameter smaller than the constraining tube and upon passing from a smaller into a larger constraining tube. A striking confirmation of the quasi-lattice or metallic-like model of plasmas is the observation that the plasma finally "explodes" into a gas cloud many times larger when its ion density decays to a critical low level.

537.56

1134 ASYMMETRICAL TRIPLE PROBE METHOD FOR DETERMINING ENERGY DISTRIBUTION OF ELECTRON IN PLASMA. T.Okuda and K.Yamamoto.

J. appl. Phys., Vol. 31, No. 1, 158-62 (Jan., 1960).

A new probe method is proposed. This method is an improvement of the floating triple probe method (Abstr. 1324 of 1956). In this method, the dimension of one operating probe is different from the other, so that the smaller probe behaves as the single probe. Thus, the measurable range of electron energy can be extended as much as that in the single probe method. The asymmetrical triple probe and double probe methods are verified experimentally. The asymmetrical triple probe method has a merit that a disturbance, which is inevitable in the single probe method, can be eliminated in this method. The electron energy distribution obtained by the new probe method is not always in accord with that obtained by the usual single probe method. The hump often observed at high energy range in the single probe method does not appear in the new method, illustrating that the latter is free from erroneous estimation due to the disturbance.

537.56

1135 TRAVELING WAVE FOCUSING FOR PLASMA CONTAINMENT. C.K.Birdsall and A.J.Lichtenberg.

Phys. Rev. Letters, Vol. 3, No. 4, 163-4 (Aug. 15, 1959).

The focusing and contraction of low density d.c. plasma columns carrying currents up to 100 mA were studies under confining field frequencies in the range 3 to 25 Mc/s. The amount of contraction was proportional to the applied power in this range. C.G.Morgan

537.56

1136 THE HEATING OF A TOROIDAL, CONFINED PLASMA IN A SLOWLY OSCILLATING MAGNETIC FIELD.
H.U.Schmidt.
Z. Naturforsch., Vol. 14a, No. 11, 975-89 (Nov., 1959).

A linearized Boltzmann equation is assumed for the velocity distribution of the plasma particles. The periodic solution gives the rates of heating by gyro-relaxation, of production of sound and of acceleration of the particles. These rates are somewhat different from the rates in an infinite cylinder of plasma. The comparison of the different mechanisms with each other and with the ohmic heating shows gyro-relaxation to be an especially suitable mechanism for achieving extreme temperatures.

537.56

1137 CONDUCTIVITY OF A WARM PLASMA.
L.Mower.
Phys. Rev., Vol. 116, No. 1, 16-18 (Oct. 1, 1959).

A theory for obtaining the conductivity of a uniform plasma as a function of frequency and temperature is presented and compared with a number of recent treatments.

537.56

1138 A LAGRANGIAN FORMULATION OF THE BOLTZMANN—VLASOV EQUATION FOR PLASMAS. F.E.Low.
Proc. Roy. Soc. A, Vol. 248, 282-7 (Nov. 11, 1958).

A variational principle is found for the Boltzmann—Vlasov equation for an ionized gas in an electromagnetic field. The principle leads to a new formulation of the problem of small oscillations about equilibrium.

537.56 : 537.32

1139 CHARACTERISTICS OF A PLASMA THERMOCOUPLE.
R.W.Pidd, G.M.Grover, E.W.Salmi, D.J.Roehling and G.F.Erickson.
J. appl. Phys., Vol.30, No.12, 1861-5 (Dec., 1959).

The operation of a Cs plasma thermocouple is described for a range of hot-junction temperatures from 1600^0 to 2600^0K and for a range of Cs pressures from 10^{-6} to 2 mm Hg. Electromotive force and short-circuit current data are presented for cells containing three different emitter substances: Ta, ZrC, and (ZrC)(UC). In the range of pressure and temperature variation studied, the observed electromotive forces are between 1 and 4.5 V. Short-circuit current depends markedly on the current emission properties of the hot electrode. The largest short-circuit current density observed for the (ZrC)(UC) emitter, is 62 A/cm^2.

537.56

1140 NEUTRON AND X-RADIATION WITH THE STABILIZED LINEAR PINCH EFFECT.
E Fünfer, H.Herold, G.Lehner, H.Tuczek and C.Andelfinger.
Z. Naturforsch., Vol. 14a, No. 4, 329-33 (April, 1959). In German.

Extension of work described in Abstr. 13396 of 1959. Under the same discharge conditions, the extent of neutron emission from the deuterium discharge and its variation in time was observed, and the spatial and energy distribution of the neutrons were measured. The influence of applied magnetic field on X-ray production was examined and discussed in terms of "runaway electrons".

C.G.Morgan

537.56 : 537.3

THE INVERSE SKIN EFFECT. See Abstr. 1092

ELECTRON EMISSION
ELECTRON BEAMS

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1141 THERMOSTIMULATED CO-EXO-ELECTRON EMISSION DUE TO APPARENT RELEASE OF WATER OF CRYSTALLIZATION. B.Sujak.
Czech. J. Phys., Vol. 8, No. 5, 616-17 (1958). In German.

The author points out the problem of distinguishing between the occurrence of exoelectron emission counting and that of the counts of spark counters due to presence of water vapour. Measurements for copper sulphate warmed at a uniform rate show three peaks in counting due to successive releases of water of crystallization while only one peak is obtained for sodium sulphate which loses its water continuously above a given temperature. G.F.J.Garlick

537.533

1142 THE PROBLEM OF EXO-ELECTRON EMISSION.
R.Seidl.
Naturwissenschaften, Vol. 46, No. 20, 573-4 (1959). In German.

The specific case of cuprous oxide is discussed. The p-type conductivity together with data on the forbidden band gap-width, the contact potential difference for Cu—Cu_2O and the work function of copper indicate an activation energy of 3.5 eV to be required for emission to occur. Occurrence of emission is tentatively associated with activation of electrons from donor states via lattice vacancy levels into the conduction band. G.F.J.Garlick

537.533

1143 ELECTRON EMISSION FROM PLASTICALLY STRAINED ALUMINUM. W.D.Von Voss and F.R.Brotzen.
J. appl. Phys., Vol. 30, No. 11, 1639-45 (Nov., 1959).

Aluminium was strained in tension under a Geiger—Müller counter. Both the electron emission associated with plastic deformation and the subsequent delayed emission were observed. An attempt was made to correlate quantitatively the emission rates with the mechanical variables, i.e. strain and rate of deformation. The model used for this correlation links point imperfections formed during deformation with the emission from the oxide surface film.

537.533 : 538.2

THE USE OF MAGNETIC MODELS IN THE INTERPRETATION OF DOMAIN EFFECTS ON AN ELECTRON BEAM. See Abstr. 287

537.533

1144 DELAYED ELECTRON EMISSION FROM GERMANIUM.
K.Seeger.
Semiconductors and phosphors (see Abstr. 9597 of 1959) p. 581-2. In German.

537.533 : 537.311 : 539.2

1145 FIELD EMISSION FROM SILICON AND TELLURIUM SINGLE CRYSTALS. C.Kleint and R.Fischer.
Z.Naturforsch., Vol.14a, No.8, 753 (Aug., 1959). In German.

The departure from linearity, observed at low fields, in the current—voltage characteristic of Si, but not of Te, is interpreted on the basis of surface states.

G.C.Williams

537.533

1146 THE NATURE OF THE SURFACE FILMS OF L-CATHODE. D.G.Bulÿginskii and E.E.Sibir.
Fiz. tverdogo Tela, Vol. 1, No. 3, 467-75 (March, 1959). In Russian.

The electron temperature T was measured in a triode with a porous W, Ba-coated cathode. The fact that T was higher than the thermodynamic temperature of the cathode was taken as a proof of the existence of a layer of a semiconducting substance on the surface of cathode of this type, the thickness of this layer being equal to at least several lengths of the free electron path of that substance. The tentatively determined activation energy of this substance was of the order of 1 eV. M.H.Sloboda

537.533

1147 PHYSICAL INVESTIGATIONS ON MASS-PRODUCED SELENIUM PHOTOELECTRIC ELEMENTS.
G.Junghähnel and H.Stegmann.
Wiss. Z. Hochsch. Maschinenbau Karl-Marx-Stadt, Vol. 1, No. 1, 34-9 (1958/59). In German.

Design of a simple element to be used as the detector part of a spectrum photometer for laboratory use. The relation, cell e.m.f. = k.log (intensity of illumination), as well as the relations between e.m.f. and flux of light, lighted area, temperature, location of elementary part of surface, and wavelength of the light were investigated. Great care is necessary when using selenium elements as measuring cells. Simple linear relationships are obtained only with a medium flux of light. Calibration curves must be used for precision measurements, particularly when using shutters. Selenium elements are particularly suitable as zero indicators in connection with null methods. J.Smuts

537.533

1148 FIELD DEPENDENCE OF PHOTOELECTRIC EMISSION FROM TANTALUM. J.L.Gumnick and D.W.Juenker.
J. appl. Phys., Vol. 31, No. 1, 102-8 (Jan., 1960).

An experimental study is made of the photoelectric emission from tantalum as it depends directly on accelerating electric field.

Observations cover a range of fields from 0 to 90 kV/cm and illumination wavelengths from 248 to 300 $m\mu$. The results are in agreement with the Fowler photoelectric theory modified by a Schottky lowering of the surface barrier. No evidence is found for a periodic deviation from this regular behaviour such as exists in its thermionic counterpart, but experimental conditions may have been inadequate for the observation of such a deviation. A new method of threshold measurement at high fields is described and applied to drawn tantalum filaments of circular cross-section. The resulting value is 4.16 eV for freshly flashed specimens and it is suggested that this is slightly greater than the lowest work function present in the surface. A Fowler determination in the same field range yields 4.13 eV. The influence of nonuniformity of the surface work function on the field dependence of photoemission and on threshold measurements is discussed.

537.533

1149 THE SECONDARY ELECTRON EMISSION FROM INDIUM AND LEAD IN SOLID AND LIQUID STATE.

V.G.Bol'shov and V.V.Zarubin.

Fiz. tverdogo Tela, Vol. 1, No. 3, 462-6 (March, 1959). In Russian.

The coefficient of true electron emission σ_i and of nonelastic electron diffraction η were measured for solid and liquid In and Pb. Throughout the investigated energy range of the primary electrons (100-2000 eV), σ_i of the solid phases was larger than that of the liquid phases, the reverse being true in the case of η. With rising temperature of the liquid phases, σ_i decreased and η remained constant. M.H.Sloboda

537.533

1150 THE THEORY OF KINETIC, ION-INDUCED ELECTRON EMISSION IN METALS. II.

S.V.Izmailov.

Fiz. tverdogo Tela, Vol. 1, No. 10,1546-56 (Oct., 1959). In Russian.

Electron emission from metals bombarded with fast, positive ions is discussed. It is postulated that ion energy is tranferred to electrons by means of the ion retarding field. The distribution of the emitted electrons along the normal velocity component is studied. The emission coefficient γ is determined in relation to the parameters characterizing the target and to the ionic mass, charge and energy. It is shown that within a wide energy range (which increases with increasing ionic mass) γ is proportional to the kinetic energy of the ions, and that in the high ion energy range the emission coefficient approaches a constant value. M.H.Sloboda

537.533

1151 ON THE THEORY OF SECONDARY ELECTRON EMISSION FROM METALS SUBJECTED TO THE ACTION OF FAST NEUTRAL ATOMS. III.

S.V.Izmailov.

Fiz. tverdogo Tela, Vol. 1, No. 10, 1557-61 (Oct., 1959). In Russian.

The mechanism of electron emission from metals bombarded with fast, neutral atoms is analysed. Starting from the assumption that, in analogy to ion-induced emission, the atom-induced electron emission is brought about by the retarding quasi-quanta, it is shown that when the energy of the moving atoms is not very high, the coefficient of the secondary, atom-induced electron emission is proportional to the square of the atom velocity; when $\tau\Phi \gg \hbar$, this coefficient is of the same order of magnitude as the coefficient of the secondary, ion-induced electron emission. M.H.Sloboda

537.533

1152 ON THE AUGER EJECTION OF ELECTRONS FROM NICKEL BY INERT GAS IONS.

Y.Takeishi.

J. Phys. Soc. Japan, Vol. 13, No. 7, 766 (July, 1958).

The energy distribution and total yield of electrons emitted from a pure nickel surface due to impact of Xe^+, A^+, Ne^+ and He^+ are calculated on the basis of the Hagstrum method (Abstr. 346 of 1955). C.G.Morgan

537.533 : 537.52

1153 A NOTE ON THE NORMAL CATHODE FALL IN THE GLOW DISCHARGES IN INERT GASES.

Y.Takeishi.

J. Phys. Soc. Japan, Vol. 13, No. 7, 767-8 (July, 1958).

Measurements of cathode fall between Ni electrodes in He, Ne, A and Xe are compared with calculated values based on theoretical estimates of secondary electron yield from Ni due to impact of Xe^+, A^+, Ne^+ and He^+(see preceding abstract). Good agreement is obtained for these conditions and also for W, Mo and BaO coated cathodes. C.G.Morgan

537.533

1154 DEPENDENCE OF SECONDARY ELECTRON EMISSION ON CRYSTAL ORIENTATION.

A.B.Laponsky and N.R.Whetten.

Phys. Rev. Letters, Vol. 3, No. 11, 510-12 (Dec. 1, 1959).

Secondary electron emission from single crystals of MgO and LiF was studied as a function of angle of incidence of primary electrons. Superposed on the expected increase in secondary emission with increasing angle of incidence is a series of maxima and minima. The more pronounced maxima correspond to orientations where the beam of primary electrons is incident along low-index crystalline directions. The angular positions of the maxima are independent of primary electron energy, and it is deduced that the effect is not due to diffraction. C.H.B.Mee

537.533

1155 TIME-DEPENDENT ELECTRON FLOW.

M.C.Pease.

J. appl. Phys., Vol. 31, No. 1, 70-6 (Jan., 1960).

The conditions of self-consistency for electron flow through arbitrary static or time-varying electric and magnetic fields are established assuming (a) nonrelativistic flow, (b) single streaming (i.e. the velocity has a single value and direction at every point) and (c) the electrons originate on a cathode not threaded by magnetic lines of force. In the case where the magnetic field is constant and uniform, a single-vector differential equation can be written which determines all possible solutions. From this equation certain time-variant solutions are developed. These are fully self-consistent — that is, large signal — solutions which exhibit some of the nonlinear behaviour that would be expected of such solutions. Probably the most interesting of these solutions — since it offers an explanation of an observed phenomenon that does fit previous theory — is a radial oscillation of the cloud in a filamentary cathode smooth bore magnetron at $\omega/\sqrt{2}$. The possible application of the other solutions to anomalous behaviour in various magnetron type devices is also discussed.

537.533

1156 NOISE PROPAGATION ON UNIFORMLY ACCELERATED MULTIVELOCITY ELECTRON BEAMS.

W.M.Mueller and M.R.Currie.

J. appl. Phys., Vol.30, No.12, 1876-80 (Dec., 1959).

The characteristics of noise propagation through a multivelocity region with linearly increasing d.c. potential have been calculated using the density-function formulation of Siegmann, Watkins, and Hsieh (see Abstr. 7081 of 1958). This type of noise transducer approximates that found experimentally in electron guns which have produced noise figures of 3 dB and less at S band. It is shown that arbitarily low values of beam noisiness can be obtained by reducing the slope of the potential profile and that adjustment of this parameter provides the practical possibility of attaining very low noise figures in slow space-charge wave amplifiers as frequency is increased. The calculated results are compared with experimental data at S band and X band.

537.533 : 538.56

1157 WAVES ON A FILAMENTARY ELECTRON BEAM IN A TRANSVERSE-FIELD SLOW-WAVE CIRCUIT.

A.E.Siegman.

J. appl. Phys., Vol. 31, No. 1, 17-26 (Jan., 1960).

The waves on a filamentary electron beam in a longitudinal d.c. magnetic field, and their interaction with a transverse-field slow-wave circuit, are studied in detail. All quantities are expressed in terms of circular polarization, with the circuit fields having arbitrary polarization. The beam is found to carry four waves: a positively polarized negative-energy slow cyclotron wave, a negatively polarized positive-energy fast cyclotron wave, and two synchronous ($\beta = \beta_e$) waves, one with positive polarization and positive energy, one with negative polarization and negative energy. The coupling of these waves to the circuit is described both in the manner of Pierce's longitudinal travelling wave tube (TWT) analysis and in a coupled-mode description. For the two special cases of positive or negative circularly polarized fields, only the appropriately polarized beam waves couple. A third special case of linear polarization is more complicated, but essentially only the two cyclotron waves couple. In each of the three cases one positive-energy and one negative-energy beam wave is involved. In each case the equations can be made identical with the longitudinal TWT equations. As one example, a positively polarized circuit can be used as a fast-wave coupler for an Adler-type parametric amplifier, and its design becomes formally identical with the longitudinal Kompfner dip problem. Published Kompfner dip data can be used. The beam-circuit interaction is found to be correctly described by considering only the apparent transverse motion of the beam's position, although the actual interaction mechanism involves both the true transverse interaction with the actual transverse electron velocities, and the longitudinal interaction of the d.c. beam velocity with the longitudinal a.c. fields off the d.c. beam axis. The latter leads to changes in longitudinal d.c. velocity of the electrons and thus accounts for the negative r.f. energies of two of the waves.

537.533

1158 ONE TYPE OF RELAXATION OSCILLATION IN AN ELECTRON BEAM. V.I.Volosok.
Dokl. Akad. Nauk. SSSR, Vol. 128, No. 3, 495-8 (Aug. 21, 1959). In Russian.

It is known that relaxation oscillations can be obtained in electron beams of high density due to the successive formation and destruction of a virtual cathode, produced when the space charge of the electrons is compensated by residual gas ions. Analogous oscillations can be obtained with low density beams due to the production of secondary electrons. A mechanism for this process is suggested and compared with experiment. A.E.I.Research Laboratory

537.533 : 537.54

1159 RELATIVISTIC MOTION OF AN ELECTRON IN AN AXIALLY SYMMETRIC FIELD WHICH MOVES ALONG THE AXIS OF SYMMETRY. M.V.Konyukov and Ya.P.Terletskii.
Zh. eksper. teor. Fiz., Vol. 34, No. 4, 1003-5 (April, 1958). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 34(7), No. 4, 692-3 (Oct., 1958).

Equations are derived for the motion of an electron in a bottle-shaped field moving along the axis of symmetry. The situation is found to be analogous to that in a betatron, except that the machine would be linear. J.W.Sturgess

537.533

1160 NUMERICAL INVESTIGATION OF A TYPICAL ELECTROSTATIC IMMERSION OBJECTIVE. E.Hahn.
Optik, Vol. 16, No. 9, 513-21 (Sept., 1959). In German.

A simplified model is adopted of the type of immersion electron lens which is used to image the surface of a flat cathode. The Wehnelt cylinder is at the same potential as the cathode, the aperture in the flat anode is negligibly small and the field variation between Wehnelt cylinder and anode is assumed to be linear along the normal dropped from the lip of the former on to the latter. The axial potential of the lens can then be calculated from tabulated functions. Electron trajectories are evaluated and the positions of the cardinal points found, for the case when the image is formed at infinity. The correct size and position of a limiting aperture for optimum image resolution is discussed. The results are compared with those for a two-electrode immersion lens (cathode and anode) followed by a condenser for producing a real image. If properly designed, this system will give a higher resolution than the three electrode lens. V.E.Cosslett

537.533

1161 DEMONSTRATION BETA SPECTROMETER. G.E.Bradley.
Amer. J. Phys., Vol. 28, No. 2, 164-5 (Feb., 1960).

The apparatus demonstrates continuous beta spectra and electron conversion lines. The rudimentary semicircular focusing spectrometer employs a small electromagnet with 4 in. diameter pole faces. The coil resistance is 18 ohms and a current of 1.5 amp is sufficient for focusing 650 keV electrons with the chamber described. The vacuum chamber is of conventional design with a radius of curvature for the focused electrons of 3.0 cm. The Geiger tube is a halogen-quenched tube with thin mica window (probably 2.5 mg/cm^2) and of $\frac{1}{4}$ in. in diameter. The threshold of the tube is approximately 500 volts. The radioactive source is evaporated from water solution upon a thin Mylar base.

537.533

1162 THE EFFECT OF MODERATELY FAST ELECTRONS ON SEVERAL METAL OXIDES.
C.v.Koch and O.Glemser.
Z. Elektrochem., Vol. 65, No. 5, 557-63 (1959). In German.

The action of 2 - 10 kV electrons on powdered oxides CdO, ZnO, TiO_2 and Al_2O_3 is described. The temperature for the reduction of CdO and ZnO by electron bombardment was sufficiently low to rule out thermal decomposition. An energy balance for the reaction has been determined. A.E.I. Research Laboratory

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ION EMISSION . ION BEAMS

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1163 METHOD OF APPROXIMATE CALCULATION OF ION OPTICAL SYSTEMS, TAKING SPACE CHARGE INTO ACCOUNT, BY MEANS OF MODELLING IN A THREE-DIMENSIONAL ELECTROLYTIC TANK. V.M.Breitman.
Dokl. Akad. Nauk. SSSR, Vol. 127, No. 6, 1187-90 (Aug. 21, 1959). In Russian.

In the absence of space charge the potential distribution of a two-dimensional electric system can be determined by means of a model in an electrolytic tank. The method fails in the presence of space-charge, which adds an extra term to the equation governing potential distribution. The new term can be allowed for by suitably shaping the base of the tank, and a technique for determining this shape and then solving the problem by successive approximations is described. A.E.I.Research Laboratory

537.534 : 621.387

1164 THE ENERGY DISTRIBUTION OF IONS FROM A HIGH-FREQUENCY SOURCE. E.T.Kucherenko and A.G.Fedorus.
Radiotekhnika i Elektronika, Vol.4, No.8, 1233-7 (Aug., 1959). In Russian.

Describes the experimental quartz discharge chamber in which excitation of the h.f. discharge (60 Mc/s) may be capacitative or inductive. The energy spectra were measured by the cylindrical capacitor method, with a resolution $U/\Delta U > 100$, and the results compared with the energy distribution functions of ions leaving an h.f. discharge without an extraction device. D.E.Brown

537.534 : 538.1

SHAPE OF THE MAGNETIC FIELD BETWEEN CONICAL POLE FACES. See Abstr. 285

537.534

1165 SPLITTING OF A BEAM OF PARTICLES BY AN ELECTROSTATIC BIPRISM. A.Septier.
C.R. Acad. Sci. (Paris), Vol. 249, No. 5, 662-4 (Aug. 3, 1959). In French.

A method of calculating the deviation of a beam of particles by an electrostatic biprism is given, and its predictions are found to agree with experimental results. The deviation is brought about without any distortion of the beam. A.E.I. Research Laboratory

537.534

1166 METHOD OF FOCUSING CHARGED PARTICLES FROM AN ACCELERATOR. V.I.Danilov and O.V.Savchenko.
Pribory i Tekh. Eksper., 1959, No. 3, 17-20 (May-June). In Russian.

Charged particles emerging from an accelerator and passing into a magnetic deflecting field can be deflected and focussed simultaneously if suitably disposed ferromagnetic blocks are placed between the deflecting pole pieces. These blocks have the effect of magnetic quadrupole lenses, and by their use the intensities of high-energy protons and mesons received by the collecting device have been trebled. A.E.I. Research Laboratory

537.534

1167 POINT-FOCUSING ABERRATION-FREE MASS-SPECTROMETER. H.Liebl and H.Ewald.
Z. Naturforsch., Vol. 14a, No. 9, 842-3 (Sept., 1959). In German.

Briefly describes the conditions to be satisfied in a point-focusing mass-spectrometer using a toroidal condenser and a magnetic sector field if it is desired to form an intermediate radial image between the electric and magnetic fields. Aberration-free operation and point focusing are maintained. T.Mulvey

537.534

1168 PARTICLE SPECTROGRAPHS OF HIGH INTENSITY: DISPERSION AND RESOLVING POWER. H.Liebl.
Z.Naturforsch., Vol. 14a, No. 9, 843-4 (Sept., 1959). In German.

Continues the calculations referred to in the preceding abstract, and shows that the production of a point intermediate image leads to an increase of intensity. An example is given of a point-focusing aberration-free toroidal condenser which produces an axial intermediate image. Such condensers have five times greater dispersion than a comparable spherical condenser. T.Mulvey

537.534

1169 DOUBLE-FOCUSING ABERRATION-FREE MASS SPECTROMETER WITH PARTICULARLY HIGH RESOLVING POWER AND DISPERSION.
H.Wachsmuth, H.Liebl and H.Ewald.

Z. Naturforsch., Vol. 14a, No. 9, 844-6 (Sept., 1959). In German.

Describes a practical realization of a mass spectrometer based on the calculations of the preceding abstract. A toroidal condenser was followed by a magnetic sector field with conical polepieces in such a way that between the fields the ions followed parallel paths in the radial direction and came to a point focus in the axial direction. In this system the resolving power is determined entirely by the electric field and the dispersion by the magnetic field. The calculated resolving power and dispersion are nearly an order better than that from a cylindrical condenser and homogeneous magnetic field with comparable radius of trajectory. T.Mulvey

537.534

1170 EARTHING OF ONE SIDE OF THE DEFLECTION CONDENSER IN MASS SPECTROMETERS.

H.Liebl and H.Wachsmuth.

Z. Naturforsch., Vol. 14a, No. 9, 846-7 (Sept., 1959). In German.

In tandem mass spectrometers using toroidal condensers and magnetic sector fields (see preceding abstract), it is convenient to earth one side of the deflection condenser. The effect of this practice, usually harmful, on resolving power and dispersion is considered. A series of apertures at different potentials, mounted at the entrance of the deflector condenser can be used to restore the performance of the system. T.Mulvey

537.534

1171 THE RANGE-ENERGY RELATION FOR THE IONS C^{12}, N^{14}, O^{16}, IN ALUMINIUM, COPPER AND GOLD IN THE ENERGY INTERVAL 50 - 110 MeV.

Yu.Ts. Oganesyan.

Zh. eksper. teor. Fiz., Vol.36, No.3, 936-7 (March, 1959). In Russian.

The ions $(C^{12})^{4+}$,$(N^{14})^{5+}$,$(O^{16})^{5+}$ and $(O^{16})^{6+}$ were accelerated in the Moscow 150 cm cyclotron. Extracted beams of 10^5– 10^6 particles/cm^{-2} sec^{-1} were passed through a focusing magnet to a screened room 12 m from the cyclotron. The analysing magnet was calibrated with the help of a deuteron beam, the energy of which was found from its range in aluminium. Particles were detected by ZnS screen and photo-multiplier, the sensitivity of which, to particles near the end of their range, was found. Curves are given for the range-energy relation of each ion in aluminium, while the results for gold and copper are tabulated and found to be in good agreement with the semiempirical calculations of Papineau. [English summary: PB 141052T-11, obtainable from Office of Technical Services, U.S. Dept of Commerce, Washington, D.C., U.S.A.]. J.H.Fremlin

537.534

1172 INVESTIGATION OF THE SPUTTERING ACTION OF POSITIVE IONS WITH ENERGIES UP TO 25 keV IN A SMALL ELECTROMAGNETIC ANALYSER.

M.I.Guseva.

Fiz. tverdogo Tela, Vol. 1, No. 10, 1540-5 (Oct., 1959). In Russian.

The sputtering ratios of various metals bombarded by ions were measured by means of an electromagnetic analyser, this being preferred to earlier methods in that it allows exact determination of the energy and mass of the ions. It was found that the sputtering ratio rises with energy and current density, though in the latter case there is a sharp break after which no rise occurs. The results agree with those obtained by other workers. A.E.I. Research Laboratory

537.534

1173 INFLUENCE OF THE ANGLE OF INCIDENCE ON SPUTTERING YIELDS.

G.Wehner.

J.appl. Phys., Vol.30, No.11, 1762-5 (Nov., 1959).

Small metal spheres are bombarded by uniform Hg^+ ion beams of low energy (125 to 800 eV). Comparison of shadow micrographs of the spheres before and after sputtering makes it possible to determine the influence of the angle of incidence on sputtering yields. Fe,Ta, and Mo showed a pronounced increase in yield at more oblique incidence of the ions while Au,Ag, and Pt showed this effect only slightly.

537.534

1174 ANGULAR DISTRIBUTION OF SPUTTERED MATERIAL.

G.K.Wehner and D.Rosenberg.

J. appl. Phys., Vol. 31, No. 1, 177-9 (Jan., 1960).

The angular distribution of material sputtered under normal Hg^+-ion incidence from flat, polycrystalline targets at 100 to 1000 eV was measured and plotted in polar diagrams. The distribution is "under cosine", approaching a cosine distribution, at higher ion energies. Mo and Fe show a more pronounced tendency to eject to the sides than Ni or Pt. Under oblique ion incidence atoms are sputtered preferentially in the forward direction.

PARTICLE ACCELERATORS

537.54 : 539.17 : 621.319.32

1175 THE OBTAINING OF A BEAM OF MONOENERGETIC PROTONS USING A [2 MeV] VAN DE GRAAFF [ACCELERATOR] AND THE STUDY OF THE RESONANCE CAPTURE OF 1-2 MeV PROTONS BY Mg^{25} AND Mg^{26}.

R.Barjon.

Ann. Phys. (Paris), Ser. 13, Vol. 4, No. 5-6, 545-94 (May-June, 1959). In French.

The first part describes the construction of the auxiliary equipment, in particular the h.f. ion source, the electrostatic analyser and its stabilized power supplies and the stabilization of the Van de Graaff itself. As a result, a stable beam of 1-10 μ could be obtained of energy known to 0.2% at energies between 0.5 and 2 MeV. The second part describes the calibration of the accelerator and its use to study the energy levels and resonance capture cross-sections of Al^{26} and Al^{27} using the reactions $Mg^{25}(p,\gamma)Al^{26}$ and $Mg^{26}(p,\gamma)Al^{27}$. J.W.Sturgess

537.54 : 537.533

POSSIBLE MOVING-FIELD LINEAR ACCELERATOR. See Abstr. 1159

537.54 : 621.319.52

1176 THE GENERATION OF DIRECT CURRENT AT HIGH POTENTIALS.

W.E.Bennett.

Research, Vol. 12, No. 12, 455-9 (Dec., 1959).

The need for a medium energy machine of high power for use in nuclear research is emphasized and a small ionized gas flow high voltage generator to give a direct current at high potential is described. Various possible applications for such an apparatus are suggested.

537.54

1177 BETATRON ENERGY CALIBRATION.

L.Katz.

Canad. J. Phys., Vol. 37, No. 12, 1455-64 (Dec., 1959).

A new betatron energy controlling circuit is described which has many advantages over those previously used. It is shown that there is a linear relationship between the helipot control on this circuit and the momentum of the electrons in the betatron just prior to striking the X-ray producing target. It is also shown that photoneutron thresholds can be used to calibrate the betatron energy scale with good internal consistency.

537.54

1178 PRODUCTION OF THE MAGNETIC FIELDS FOR THE ACCELERATION OF ELECTRONS IN AN AIRCORED BETATRON.

G.Hentze.

Exper. Tech. der Phys., Vol. 7, No. 4, 145-56 (1959). In German.

To avoid power losses due to large stray fields of a betatron using Helmholtz coils, two other coil arrangements have been used. These are called the "flat coil" betatron and the "cylindrical coil" betatron. Their construction and performance are given and applications are outlined. J.W.Sturgess

MAGNETISM

(The magnetic properties of solids are included under Solid-State Physics; similarly for Liquid State and Gaseous State)

538.1

1179 APPARATUS DRAWINGS PROJECT. REPORT NUMBER 2. MAGNETIC FIELD OF A CIRCULAR COIL.

R.G.Marcley.

Amer. J. Phys., Vol. 28, No. 2, 147-50 (Feb., 1960).

The apparatus to be described will permit a quanitative investigation of the magnitude and direction of a 3-dimensional, cylindrically symmetrical B field, produced by a current-carrying coil. A 400 c/s current through the coil produces a time-varying field which is measured with an accuracy of 2% by a moveable search coil, simple preamplifier, and a.c. voltmeter.

538.1 : 550.3

1180 ON THE ANALYTIC CONTINUATION OF TWO-DIMENSIONAL MAGNETIC FIELDS.

V.N.Strakhov.

Dokl. Akad. Nauk SSSR, Vol. 126, No. 5, 987-9 (June 11, 1959). In Russian.

The approximative series-method of Andreev [Izv. Akad. Nauk SSSR, Ser. fiz. geofiz., No. 3 (1949)] is refined and generalized.
P.Roman

538.27

1181 THE COUPLING OF A SPIN SYSTEM TO A CAVITY MODE. K.W.H.Stevens and B.Josephson, Jr.
Proc. Phys. Soc., Vol. 74, Pt 5, 561-75 (Nov., 1959).

The problem of a non-interacting spin system coupled to a damped resonant cavity is formulated wave-mechanically. An exact solution of the Schrödinger equation is found for this system, and the expectation value M_z of the z component of total spin angular momentum S_z is determined in series form from an expansion of the solution. The expectation value is obtained exactly and in closed form only for very small values of the total spin quantum number S. Approximate solutions in closed form are obtained for the initial conditions $M \cong S$ and $M \cong -S$. For the former condition, $\langle t|S_z|t\rangle$ exhibits exponential decay for small values of t. The approximations break down for larger values of t, but damped oscillatory behaviour is suggested. The results are discussed in terms of the total number of spins, and a value of at least 10^{18} spins seems necessary for an appreciable exponential change in $\langle t|S_z|t\rangle$ to occur, under typical experimental conditions. Reasons are given why a simple, closed form for $\langle t|S_z|t\rangle$ seems unlikely for the general case of arbitrary S, and some mathematical difficulties are considered in more detail.

538.27

1182 ADIABATIC PASSAGES IN NUCLEAR MAGNETIC RESONANCE WITH THE ROTATING CO-ORDINATE METHOD. G.Bonera and L.Giulotto.
Nuovo Cimento, Vol. 14, No. 2, 435-42 (Oct. 16, 1959).

The cases of adiabatic passages in nuclear magnetic resonance are studied with the rotating coordinate method. The expressions for the corresponding nuclear signals, already found by Bloch, are rederived by this method. In addition a simple geometrical model, which describes the movement of the nuclear magnetization during a slow passage, is derived.

ELECTROMAGNETISM
MAGNETOHYDRODYNAMICS

538.3

1183 REMARKS ON THE CONFORMAL INVARIANCE OF ELECTRODYNAMICS AND THE BASIC EQUATIONS OF DYNAMICS. F.Bopp.
Ann. Phys. (Leipzig), Folge 7, Vol. 4, No. 1-5, 96-102 (1959).
In German.

Isolating the source of the lack of general converance of the equations of electrodynamics, a new proof is given for their covariance under the group of conformal coordinate transformations (Cunningham and Bateman, 1910). Moreover, it is shown that the equations of motion, too, are conform covariant if the mass is transformed like a reciprocal length. Similar parameter transformations in conjunction with transformations of the conformal group (dilatations corresponding to scale transformations of the field) have also been considered by Heisenberg et al. in recent work on the symmetries of the non-linear equation of Heisenberg and Pauli. (Abstr. 11822 of 1959).
W.A.Hepner

538.3 : 539.2

ELECTRODYNAMICS OF CHARGE CARRIERS OF NEGATIVE EFFECTIVE MASS IN CRYSTALS. See Abstr. 544

538.3

1184 THE INTEGRALS OF DRIFT EQUATIONS. A.I.Morozov and L.S.Solov'ev.
Dokl. Akad. Nauk SSSR, Vol. 128, No. 3, 506-9 (Sept. 21, 1959).
In Russian.

The motion of particles in a slowly time- and space-varying electromagnet field, can be approximately described by the "drift equations". The authors derive trajectories of such particles by assuming that the particle velocity component perpendicular to the magnetic field intensity vector, is constant. The resultant differential equation for particle position has then the usual Lagrangian form. The solution of such an equation is studied for simple types of magnetic fields (i.e. for rectangular, axial and screw symmetries) As an illustration, the authors consider trajectories in a magnetic field due to superposition of circular, variable and constant currents: (1) "locked" particles, moving almost entirely in the direction of circular current and (2) "escaping" particles, following the lines of force of the magnetic field. Trajectories of both types of particles are studied.
J.K.Skwirzynski

538.3

1185 INSTABILITY OF CERTAIN ELECTROHYDRODYNAMIC SYSTEMS. O.M.Stuetzer.
Phys. of Fluids, Vol. 2, No. 6, 642-8 (Nov.-Dec., 1959).

The production of ion drag pressure under dynamic conditions, i.e., with the carrier medium in motion, is theoretically investigated. It is shown that for constant applied voltage the pressure increases with increasing velocity of the carrier fluid. This can lead to instability of the system which is theoretically discussed and experimentally demonstrated.

538.3

1186 ELECTROSTATIC FIELD ABOUT AN ION MOVING SLOWLY IN A PLASMA. S.Rand.
Phys. of Fluids, Vol. 2, No. 6, 649-52 (Nov.-Dec., 1959).

A particle treatment is used to determine the potential distribution about an ion moving subsonicly through a plasma. A fore-aft asymmetry is obtained which has the effect of producing a drag on the ion. This asymmetry is the most important difference between the results of this treatment and those obtained for the subsonic case by the linearized treatment of the electrohydrodynamic equations.

538.3

1187 THE FUNCTION OF MAGNETIC STREAM IN A THREE-DIMENSIONAL FIELD. V.I.Skobelkin.
Dokl. Akad. Nauk SSSR, Vol. 128, No. 2, 280-3 (Sept. 11, 1959).
In Russian.

Formulation of the variational principle, giving an approximate solution of boundary value problems for ferromagnetic systems in a three-dimensional current field. The magnetic induction is constructed as the vector product of gradients of two independent potential fields. The variational principle is applied to the integral of Lagrangian over the magnetic energy stream function. The resultant elliptic differential equations are formulated, together with appropriate boundary conditions. The uniqueness and the convergence of solution is discussed.
J.K.Skwirzynski

538.3

1188 THE UNIFIED ELECTROMAGNETIC EQUATION AND ITS PROPERTIES IN CURVILINEAR COORDINATE SYSTEMS. M.Itoh.
Rev. Univ. Tucuman A, Vol. 12, No. 1-2, 85-106 (1959).

Maxwell's two electromagnetic equations are unified into a single equation with the aid of the operational calculus. The general curvilinear coordinate systems in which one component of the unified electromagnetic equation may satisfy a partial differential equation of the second order are limited to two kinds. These are the general cylindrical and the general sphero-conical coordinate systems, and it is shown how to obtain directly the solutions of the unified field equation from them.
T.R.Carson

538.3

1189 ON THE "ESCAPE SPEED" OF A CONDUCTING FLUID IN A TRANSVERSE MAGNETIC FIELD. W.J.Guman.
Phys. of Fluids, Vol. 2, No. 6, 714 (Nov.-Dec., 1959).

Shows that the escape velocity of a rapidly accelerated piston in a perfectly electrically conducting fluid in a transverse magnetic field depends on the ratio of magnetic to hydrodynamic pressure.
C.G.Morgan

538.3

1190 A PROBLEM ABOUT A PISTON IN MAGNETOHYDRODYNAMICS. G.Ya.Lyubarskii and R.V.Polovin.
Dokl. Akad. Nauk SSSR, Vol. 128, No. 4, 684-7 (Oct. 1, 1959).
In Russian.

A perfectly conducting fluid fills the semi-infinite space bounded by a perfectly conducting piston with a plane face. Initially the fluid is at rest and the magnetic field uniform in any direction. It is shown here that if the piston moves with uniform velocity into the the fluid two magnetoacoustic shock waves (one fast, one slow) precede it; but if it moves uniformly away from the fluid, two rarefaction waves will be generated. In neither case do Alfvén waves or shocks arise.
O.Penrose

538.3

1191 A NON-STATIONARY PROBLEM OF MAGNETOHYDRODYNAMICS FOR A HALF-PLANE. S.A.Regirer.
Dokl. Akad. Nauk SSSR, Vol. 127, No. 5, 983-6 (Aug. 11, 1959).
In Russian.

A conducting viscous fluid moves in the half-plane $y > 0$, the only non-vanishing components of v and H being $v_x(t,y)$, $H_x(t,y)$ and H_y = const. At infinity, v_x and H_x vanish; at $y = 0$ they are prescribed functions of time, and at $t = 0$, prescribed functions of y. Proofs of the existence and uniqueness of solutions of the equations for v and H are outlined. A method of solving the equations, based on the Laplace transform, is illustrated by treating the case where $v_x(t,0)$ = const. and the other boundary and initial values are zero.
O.Penrose

538.3 : 537.56

1192 OSCILLATIONS IN THE B-1 STELLARATOR. W.Bernstein, A.Z.Kranz and F.Tenney.
Phys. of Fluids, Vol. 2, No. 6, 713-14 (Nov.-Dec., 1959).

A search for regular oscillations occuring at five modes of hydromagnetic instabilities shows clearly defined oscillations in the range 30 kc/s to 200 kc/s.
C.G.Morgan

538.3

1193 NONLINEAR ALFVÉN WAVES IN A COLD IONIZED GAS. D.Montgomery.
Phys. of Fluids, Vol. 2, No. 6, 585-8 (Nov.-Dec., 1959).

Nonlinear constant-profile Alfvén waves are studied in an ionized gas in which thermal motions are negligible. The system of differential equations possesses numerous integrals, and can be solved up to a single quadrature. Many properties of the waves can be inferred without performing any numerical integrations. The waves necessarily involve nonzero magnetic field components in both directions perpendicular to the direction of propagation, and plane polarized waves are impossible except in the special case of equal mass particles. Circularly polarized modes are also a special case, and, unlike the more general solutions, involve neither longitudinal electric fields nor compression of the gas.

538.3

1194 HIGH-SPEED SHOCK WAVES IN A MAGNETIC ANNULAR SHOCK TUBE. R.M.Patrick.
Phys. of Fluids, Vol.2, No.6, 589-98 (Nov.-Dec., 1959).

Experiments were carried out with two magnetic field configurations ahead of the shock front, the first with a magnetic field ahead of the shock front in the direction of motion of the shock. In the second configuration the magnetic field ahead of the shock had its principal component in the plane of the shock front and a small component in the direction of the shock motion. The continuum radiation emitted by the shock-heated plasma was measured with photomultipliers. Use of probes to measure the change in the local magnetic field in the shock front was investigated. With the second configuration shock velocities in excess of 4×10^7 cm/sec were measured in hydrogen. For these high-speed shock waves, shock thicknesses, obtained from measured rise times of the emitted visible radiation, are thinner than the mean free path in the shock-heated plasma, an observation which agrees with a theoretical prediction.

538.3

1195 THEORY OF THE FLOW IN THE MAGNETIC ANNULAR SHOCK TUBE. N.H.Kemp and H.E.Petschek.
Phys. of Fluids, Vol.2, No.6, 599-608 (Nov.-Dec., 1959).

The magnetic annular shock tube uses a magnetic field to drive a shock wave through an annular region, producing a very high-temperature plasma (cf. Patrick, preceding abstract). It is shown that this particular configuration allows a fairly precise calculation of the flow parameters. Numerical calculations of the significant flow properties for a complete range of the initial field strength and orientation have been made and are presented graphically.

538.3

1196 MOVING MAGNETIC FIELD BEHIND A STRONG DEUTERIUM SHOCK. F.R.Scott and R.F.Wenzel.
Phys. of Fluids, Vol.2, No.6, 609-13 (Nov.-Dec., 1959).

By introducing a spiral in the return conductor of a conical discharge tube with a hollow electrode, a magnetic multipole was observed propagating down a cylinder extending out from the hollow electrode. The magnetic field appears to have an extremely complicated internal structure when observed with small magnetic probes; when observed by an external loop, the net axial leakage flux shows a structure consistent with the characteristics of a shock produced deuterium plasma.

538.3

1197 MAGNETOHYDRODYNAMIC SHOCK WAVES WHICH IONISE A GAS. A.G.Kulikovskii and G.A.Lyubimov.
Dokl. Akad. Nauk SSSR, Vol. 129, No. 1, 52-5 (Nov. 1, 1959).
In Russian.

It is shown that in non-stationary problems connected with ionizing shock-waves, the shock-wave might be preceded by an electromagnetic wave. In many cases the boundary conditions on the shock-wave are insufficient to determine simultaneously the intensity of the shock-wave and the intensity of the emitted electromagnetic wave. Subsidiary conditions are obtained which relate quantities which relate quantities before and after the shock-wave. The conditions depend on the relative ratios of the dissipation coefficients in the transitional zone.
P.Roman

538.3

1198 SOME INTERIOR PROBLEMS OF HYDROMAGNETICS. J.D.Cole and J.H.Huth.
Phys. of Fluids, Vol.2, No.6, 624-6 (Nov.-Dec., 1959).

The static boundary problems of line currents and dipoles in a perfectly conducting static fluid are considered first. The perturbing effect of moving fluid on the magnetostatic boundary about an isolated line current is then investigated. In this case, the initial circular boundary is distorted into an ellipse with major axis transverse to the direction of flow.

538.3

1199 FLOW OF AN INCOMPRESSIBLE FLUID IN A HYDROMAGNETIC CAPACITOR. C.C.Chang and T.S.Lundgren.
Phys. of Fluids, Vol.2, No.6, 627-32 (Nov.-Dec., 1959).

An incompressible electrically conducting fluid is contained in a torus of rectangular cross section. A uniform magnetic field is maintained along the polar axis of the tube. A radial electric field is suddenly applied, causing the fluid to flow through the tube. Overall properties such as the time required to reach steady state, resistance and capacitance are calculated, and an equivalent electrical circuit is given.

538.3

1200 MAGNETOHYDRODYNAMIC WAVES IN WAVE GUIDES. R.Gajewski.
Phys. of Fluids, Vol.2, No.6, 633-41 (Nov.-Dec., 1959).

Propagation of magnetohydrodynamic waves is investigated in a fluid bounded by a cylindrical surface of constant, but not necessarily circular, cross-section. The fluid is assumed to be nonviscous and perfectly conducting with a constant magnetic field applied parallel to the walls of the cylinder. It is shown that the following types of waves can propagate in such a wave guide: (1) transverse waves propagating without dispersion with the velocity of Alfven waves; (2) a longitudinal wave, identical with the wave of the principal mode for an acoustic wave guide; (3) waves having both longitudinal and transverse components propagating with a dispersion, their group and phase velocity being close to the respective velocities for an acoustic wave guide; (4) waves having both longitudinal and transverse components propagating with a small dispersion, their group and phase velocity being close to the velocity of Alfven waves. When the applied frequency is too low, damping of certain modes appears for waves of type (3) only; the cut-off frequencies turn out to be slightly higher than the corresponding cut-off frequencies for an acoustic wave guide.

ELECTROMAGNETIC WAVES AND OSCILLATIONS

538.56

1201 THE ABSOLUTE STABILITY OF A MOLECULAR OSCILLATOR USING A BEAM OF AMMONIA MOLECULES. N.G.Basov and A.N.Oraevskii.
Radiotekhnika i Elektronika, Vol. 4, No. 7, 1185-95 (July, 1959).
In Russian.

Discusses theoretically the dependence of a molecular oscillator frequency on its main parameters, i.e. the natural frequency of the volume resonator, the intensity of the molecular beam, and the width and form of the spectral line. It is shown that an oscillator using two opposed molecular beams and the inversional ammonia transition length 3.2 is capable of an absolute frequency stability of the order 10^{-10}-10^{-11}. A figure shows the main dimensions of the proposed oscillator.
D.E.Brown

538.56 : 536.7 : 537.52

OPTICAL MASERS: POSSIBILITY OF NEGATIVE TEMPERATURE PRODUCTION. See Abstr. 1109

538.56

1202 OPTICAL MASER DESIGN.

J.H.Sanders.

Phys. Rev. Letters, Vol. 3, No. 2, 86-7 (July 15, 1959).

It is proposed to excite the working medium by electron impact in a discharge into two levels separated by the optical frequency, where the upper level has considerably longer lifetime than the lower one. The medium would be situated between the plates of a Fabry—Perot etalon, used as the cavity of the maser, whose plate separation is large enough to make the width of the fringes due to spontaneous emission larger than the instrumental width. Maser oscillation would then appear as a sharp line of instrumental width superimposed upon the background of spontaneous emission.

J.M.Baker

538.56 : 621.3.013

1203 DERIVATION OF THE SPEED OF ELECTROMAGNETIC WAVES IN TERMS OF DIELECTRIC CONSTANT, MAGNETIC PERMEABILITY, AND RATIO OF CHARGE UNITS.

F.G.Werner and D.R.Brill.

Amer. J. Phys., Vol. 28, No. 2, 126-8 (Feb., 1960).

An elementary derivation of the expression for the propagation speed of a change in the electromagnetic field in terms of the dielectric constant, the magnetic permeability, and the ratio of magnetic to static units of charge is given. The only knowledge of electrodynamics required is familiarity with the expressions for the electrostatic charge on a parallel plate condenser, the magnetic field in a long solenoid, and the induced e.m.f. in a loop. Also easily found are expressions for the characteristic impedance of the medium (or the vacuum) and displacement current. These are introduced in a rather directly conceivable physical manner. No use is made of calculus or vector analysis proper. No swiftly moving bodies are considered. Units are kept general so that reduction to any particular unit system is easy.

538.56 : 534.2

1204 THE EXACTNESS OF THE SOLUTION OF A PROBLEM OF DIFFRACTION OR OF PROPAGATION.

P.Poincelot.

C.R. Acad. Sci. (Paris), Vol. 249, No. 10, 950-1 (Sept. 7, 1959).
In French.

It is suggested that the previously obtained uniqueness condition for sinusoidal solutions (Abstr. 8390 of 1959) can be used as an accuracy criterion for solutions of diffraction or propagation problems, particularly in the presence of sharp boundaries.

J.K.Skwirzynski

538.56

1205 DIFFRACTION OF ELECTROMAGNETIC WAVES FROM STRIPS OF FINITE WIDTH.

G.A.Grinberg.

Dokl. Akad. Nauk SSSR, Vol. 129, No. 2, 295-8 (Nov. 11, 1959).
In Russian.

Although such problems can be solved by separation of variables, leading to a series of Mathieu functions, such solutions are very slowly convergent for $kh > 1$, where k is the wave-number and h is the width of the strip. The author applies to this problem a new method of solution of Fredholm integral equations (Dokl. Akad. Nauk SSSR, Vol. 128, No. 3, 450-3 1959), whose kernels depend only on the absolute value of difference of arguments; the advantage of this method, which is also developed here, depends on the facility of obtaining asymptotic solution to such equations when $kh \gg 1$.

J.K.Skwirzynski

538.56

1206 ON THE DIFFRACTION OF ELECTROMAGNETIC PULSES BY CURVED CONDUCTING SURFACES.

J.R.Wait and A.M.Conda.

Canad. J. Phys., Vol. 37, No. 12, 1384-96 (Dec., 1959).

Starting with the known steady-state solutions for diffraction by a perfectly conducting convex surface, the corresponding transient responses are derived using Fourier—Laplace inversion. Explicit results are given for an incident wave which varies with time as a step function.

538.56 : 534.26

1207 DIFFRACTION BY AN INFINITE SLIT.

H.Levine.

J. appl. Phys., Vol. 30, No. 11, 1673-82 (Nov., 1959).

The diffraction of plane waves by an infinite slit is investigated, with attention drawn to the case of grazing incidence and for wavelengths short compared with the slit width. The wave pattern is time harmonic and two dimensional, with identical behaviour in all planes normal to the slit axis. At the coplanar screens bordering the slit, the normal derivative of the wave-function is assumed to vanish, for this boundary condition provides a problem with calculable diffraction even at grazing incidence. A useful formulation of the boundary value problem involves Fourier transforms of field distributions in the plane of the screens, and enables the transmission cross-section of the slit to be directly inferred. The screen distributions are characterized by a pair of integral equations which allow systematic approximation at short wavelengths for arbitrary angle of incidence. A few terms in the asymptotic development of the cross-section at oblique incidence are obtained explicitly, and since this development fails at grazing incidence, the analogous terms for the latter case are derived by a limiting process. In the related problem of plane-wave scattering by an infinite strip, a comparison is made with the variational results based on strip distributions of primary or unperturbed form.

538.56

1208 PROPAGATION OF ELECTROMAGNETIC WAVES IN A MULTISTREAM MEDIUM AT GYROMAGNETIC RESONANCE.

J.Neufeld.

Phys. Rev., Vol. 116, No. 1, 19-20 (Oct. 1, 1959).

An electromagnetic wave travelling in a multistream medium in the direction of an applied magnetic field is described by a dispersion relation as follows:

$$c^2k^2 = \omega^2 - \Sigma_i \omega_i{}^2 \omega/(\omega - kV_i \mp \Omega_i),$$

where ω is the frequency, k is the wave vector, ω_i is the Langmuir frequency, Ω_i is the gyromagnetic frequency associated with the beam i, and V_i is the velocity of the beam $i(i=1, 2, 3 \cdots n)$. For the case of gyromagnetic resonance $(\omega = \Omega_i)$, growing and evanescent waves occur if:

$$M = 27[\Sigma_i \omega_i{}^2/V_i]^2 - 4\Omega_g{}^4/c^4 > 0, \text{ where } \Omega_g = \Omega_i \text{ for all i's,}$$

and unattenuated waves occur if $M \leq 0$.

538.56

1209 SURFACE WAVE PROPAGATION OVER A SAND-COVERED CONDUCTING PLANE.

A.G.Mungall and D.Morris.

Canad. J. Phys., Vol. 37, No. 12, 1349-56 (Dec., 1959).

The velocity of surface waves propagated over a sand-covered metal plane has been investigated experimentally as a function of the depth of the sand. Measurements were made at a frequency of approximately 9000 Mc/s, using a phase comparison system. A periodic variation of surface wave velocity with sand depth was found, as predicted theoretically. The possible application of the results to effects found in precise microwave distance measuring techniques is discussed.

538.56

1210 SOME METHODS FOR STUDYING WAVE-PROPAGATION IN A UNIFORM MAGNETO-IONIC MEDIUM.

V.A.Bailey.

J. atmos. terrest. Phys., Vol. 12, No. 2-3, 118-25 (1958).

The difficulty in using the classical general formulae of Appleton, for determining the refractive and absorption indices and the polarization of each of the two wave-modes, is primarily due to the presence of the radical term $\rho = (\gamma_t^4\delta^2 + \gamma_l^2)^{1/2}$ where δ is the reciprocal of a given complex number. This difficulty has been overcome by means of each of four methods of calculation developed in the School of Physics of the University of Sydney. The first three, previously published, are presented briefly. The fourth method makes use of certain approximations. On applying them to Appleton's formulae, by taking $s = 2\gamma_l\gamma_t^{-2}(1 + \alpha + i\beta)$, and substituting

$$(1 + s^2)^{1/2} \cong \frac{4 + 3s^2}{4 + s^2} \text{ or } s. \frac{4s^2 + 3}{4s^2 + 1}$$

according as $|s| \lessgtr 1 (s^2 \text{ not } \cong -1)$, good formulae result for M^2 (square of the complex refractive index) which cover all possible situations with an error of less than 1%. Other applications of these approximations are given.

538.56 : 621.372.823

1211 A NON-ISOTROPIC ELLIPTICAL WAVEGUIDE.

E.S.Kovalenko.

Dokl. Akad. Nauk SSSR, Vol. 128, No. 2, 276-9 (Sept. 11, 1959).
In Russian.

A waveguide filled with a magnetized ferrite is considered. The solution is obtained for the propagation component of the electric field in terms of Mathieu functions and a transcedental equation is derived for the critical propagation constant. The polarization properties of the system are discussed. J.K.Skwirzynski

538.56 : 621.372.8

1212 THE THEORY OF WAVEGUIDES OF VARIABLE CROSS-SECTION.

V.L.Pokrovskii, F.R.Ulinich and S.K.Savvinykh.
Radiotekhnika i Elektronika, Vol. 4, No. 2, 161-71 (Feb., 1959).
In Russian. English summary: PB 141106T-13 obtainable from Office of Technical Services, U.S. Dept. of Commerce, Washington, D.C., U.S.A.

The e.m. wave propagation in a plane waveguide with perfectly conducting walls, whose angle of inclination to the waveguide axis is assumed to be small although the total (monotonic) change in cross-section is finite, is evaluated. The differential equation is solved approximately by a combination of the Wentzel—Kramers—Brillouin method and the perturbation method. The transmission, reflection and scattering coefficients are worked out when only one wave of index 1 is propagated, and two particular cases of waveguide are considered. It is shown that only the phase changes are substantially dependent on the form of the waveguide, the amplitudes being mainly determined by irregularities at joints of the regular waveguide sections. See also following abstract. D.E.Brown

538.56 : 621.372.8

1213 A RECTANGULAR WAVEGUIDE OF VARIABLE CROSS-SECTION. M.S.Ryvkin.

Radiotekhnika i Elektronika, Vol. 4, No. 9, 1465-74 (Sept., 1959).
In Russian.

Considers the e.m. wave propagation down a rectangular waveguide with perfectly conducting walls and slowly (monotonically) increasing cross-section. See preceding abstract for the general mathematical method. General expressions are worked out for the reflection and scattering coefficients, and applied to the particular case of two square waveguides of different sides with an intermediate trumpet-shaped adaptor. D.E.Brown

538.56 : 621.372.821

1214 SURFACE WAVES IN FERRITE WAVEGUIDES.

A.L.Mikaélyan and A.K.Stolyarov.
Radiotekhnika i Elektronika, Vol. 4, No. 7, 1079-93 (July, 1959).
In Russian.

Starts by summarizing the familiar properties of waves in 3 types of parallel plane waveguide: (1) with no conducting side walls and containing an ordinary dielectric layer with faces perpendicular to the planes; (2) with one conducting side wall next a dielectric layer face; (3) normal rectangular waveguide — 2 conducting side walls — with a dielectric layer face next one side wall. These 3 cases are next discussed theoretically with ferrite replacing the dielectric layer. Experimental curves are illustrated, showing the direct and reverse wave attenuations as functions of external magnetic field for different thickness of ferrite layer in rectangular waveguide. The results indicate that a waveguide can be produced with cutoff in a single direction of propagation. D.E.Brown

538.56

1215 ELECTROMAGNETIC WAVE DIFFRACTION AT THE OPEN END OF A HELICAL WAVEGUIDE. P.S.Mikazan.

Dokl. Akad. Nauk SSSR, Vol. 128, No. 3, 502-5 (Sept. 21, 1959).
In Russian.

Uses Vainshtein's functional equation method (1953) to find the reflection coefficients and radiation pattern from the end of a helical waveguide consisting of ideally conducting, infinitely thin ribbon wound round a cylinder of radius a. The ribbon is assumed narrow enough to neglect the transverse component of the ribbon current. Illustrations refer to the cases $d/2\pi a = \tan 15^\circ$, where d = pitch of helix, and $ka = 1.36728, 0.9856, 0.72828$, where $k = \omega/c$. D.E.Brown

538.56

1216 HELICAL FIELDS.

H.Poritsky.
J.appl. Phys., Vol.30, No.11, 1828-37 (Nov., 1959).

Devoted to a study of helical fields which are invariant under screw motions of space which move a certain helix into itself. Simple, analytic, helically invariant solutions of the Laplace equation are given and combined to describe the electrostatic field of a charged helix, and of the magnetic field of a helical electric current. A flux function ψ is introduced for solenoidal helical vector fields, and differential equations resembling Cauchy—Riemann equations are derived for the potential function φ and the flux function ψ. Certain graphical flux plotting methods are outlined and illustrated, and network analogies are suggested for solving these fields.

538.56 : 534.4

DESIGN OF DIRECTIONAL ARRAYS. See Abstr. 1006

538.56 : 621.396.677.55

1217 CORNER-DRIVEN COUPLED SQUARE LOOP ANTENNAS. S.Prasad.

Canad. J. Phys., Vol. 37, No. 12, 1407-17 (Dec., 1959).

A theory for two identical square loop aerials driven in the zeroth-phase sequence (voltages in phase at all four corners) and the second-phase sequence (voltages in and out of phase at the corners) is formulated. Eight independent integral equations are obtained. They are solved individually by the method of iteration, and first-order formulae are obtained for the current distributions and driving point impedances. For each phase sequence, the sum of the symmetrical and antisymmetrical impedances gives the self-impedance and the difference between them gives the mutual impedance. Self and mutual impedances are also obtained for a superposition of the two phase sequences.

538.56

1218 FRONTAL PERTURBATION OF A TROPOSPHERIC SCATTER PATH. D.R.Hay and G.E.Poaps.

Canad. J. Phys., Vol.37, No.11, 1272-82 (Nov., 1959).

A 2-year study of 500 Mc/s radio transmission over an 85-mile path near Ottawa has shown that the signal fading rate rises well above the diurnal maximum when the transmission path is perturbed by a weather front. The fading rate reaches a maximum when the upper boundary of the frontal zone is 3000 feet above the centre of the radio path, and the fading rate remains high as long as any part of the frontal zone is between the surface and 3000 feet. A similar relationship between frontal position and signal fading is found for Arctic, Maritime, or Polar fronts in the Ottawa area, but the Arctic fronts provide the clearest definition. There is some indication that high fading rate also may be associated with horizontal layers of contrasting humidity at low levels in the troposphere.

538.56 : 551.5

1219 LOW-FREQUENCY REFLECTION IN THE IONOSPHERE. I. H.Poeverlein.

J. atmos. terrest. Phys., Vol. 12, No. 2-3, 126-39 (1958).

A theory of low-frequency reflection in the ionosphere is developed. At wavelengths long compared to the layer thickness, the ionospheric layer is considered as a thin conductive sheet, that leads to a discontinuity of the electromagnetic field. A thicker layer is subdivided into many thin (or differential) sublayers. The field is then thought of as a superposition of many partial waves, each of which is reflected by an individual sublayer. An additional penetrating wave must be assumed. At the lowest frequencies (in the case of thin-sheet reflection) the currents in the layer are horizontal and the reflection is of the metallic type, showing reversal of the horizontal E-component. Dielectric-type reflection with sign or phase transition at the Brewster angle is obtained at higher frequencies, if vertical and horizontal current density components are of comparable magnitude. The frequencies under consideration are roughly 1-100 kc/s.

538.56 : 551.5

1220 LOW-FREQUENCY REFLECTION IN THE IONOSPHERE. II. H.Poeverlein.

J. atmos. terrest. Phys., Vol. 12, No. 4, 236-47 (1958).

See preceding abstract. Various ranges of data are specified and their reflection characteristics are investigated. Metallic-type reflection is found at high electron concentration and dielectric-type reflection at medium electron concentration above a certain frequency limit. In this latter case, the currents in the ionospheric layer have the direction of the terrestrial magnetic field and the propagation in the layer is very peculiar. Some consequences of the theory are discussed with references to observations where possible. Among them there are statements about phase, sign, and Brewster case and possibilities of transmission through a layer. The final section brings some remarks on the theory, mainly on the field-strength quantities introduced. These quantities allow an interpretation which points at a close relationship to Budden's theory.

538.56

1221 THE FADING OF RADIO WAVES REFLECTED FROM THE E LAYER. B.Landmark.

J. atmos. terrest. Phys., Vol. 10, No. 5-6, 288-95 (1957).

The amplitude and phase of waves of frequency 2 Mc/s reflected vertically from the E layer were studied. It was found that there were regions in the wave pattern, of extent D, at the centre of which the phase-path exceeded that at the edges by ΔP. When $\Delta P/D < 0.025$ approximately, the variations of amplitude and phase were associated as theory would be if the phase variation was caused by a concavity in the reflecting layer. There resulted a "burst" of amplitude caused by focusing, inside which there was comparatively rapid fading. The $\Delta P/D > 0.025$, the conditions became more complicated, but on one occasion could still be analysed in terms of a moving concavity in the layer. Observations made at night on waves of frequency 200 kc/s reflected at an angle of incidence of about 40° were explicable in terms of the same model.

538.56

1222 THE ABSORPTION OF SHORT RADIO WAVES IN THE IONOSPHERE. J.D.Whitehead.

J. atmos. terrest. Phys., Vol. 10, No. 1, 12-19 (Jan., 1957).

It is shown that the reflection coefficients (ρ) measured for radio waves on 2 and 4 Mc/s reflected vertically from the ionosphere do not fit the expression

$$-\log \rho = A(f + f_L)^{-2} \qquad (1)$$

appropriate to "nondeviative" absorption, and this failure cannot be ascribed to excessive "deviative" absorption. If the measured values are inserted into the expression

$$-\log \rho = C + B(f + f_L)^{-2} \qquad (2)$$

it is found (a) C varies with the sun's zenith angle but not with solar epoch; (b) B is a very variable quantity, it depends on the solar epoch and is greatest in winter. With values of B and C deduced from measurements on 2 and 4 Mc/s, equation (2) gives a reasonable approximation to the measured values of ρ on 2.4, 3.2, and 4.8 Mc/s

538.56 : 621.396.946

1223 REFRACTION OF VERY HIGH FREQUENCY RADIO SIGNALS AT IONOSPHERIC HEIGHTS.

S.Weisbrod and L.Colin.

Nature (London), Vol. 184, 119 (July 11, 1959).

A consideration of the refractive errors encountered in the radio tracking of space vehicles due to the influence of the earth's atmosphere. Tropospheric refraction is only appreciable at low elevation angles, but ionospheric refraction introduces an error which increases with elevation to a maximum value depending on the height of the ionospheric layer. Graphs are given of the variation of these errors with elevation angle. G.M.Brown

Radiofrequency Spectroscopy Techniques

538.56

1224 A SMALL GRATING SPECTROMETER FOR MILLIMETRE WAVES (0.3-1.6 mm).

A.Hadni and E.Decamps.

C.R. Acad. Sci. (Paris), Vol. 249, No. 20, 2048-50 (Nov. 16, 1959). In French.

A compact grating spectrometer has been constructed, using the techniques of the far infrared region, to operate in the wavelength range from 0.3 to 1.6 mm. The source is a mercury discharge lamp and a detector of the Golay type is used. The spectra of both water vapour and benzophenone have been studied, giving results in good agreement with those obtained using larger instruments.

S.A.Ahern

538.56

1225 MEASUREMENT BROADENING IN MAGNETIC RESONANCE. O.E.Myers and E.J.Putzer.

J. appl. Phys., Vol.30, No.12, 1987-91 (Dec., 1959).

Phase-detection techniques used in recording magnetic resonances are the source of a measurement broadening. Results of a general mathematical treatment for arbitary line shape and of machine computation for a Lorentz line shape lead to a series of curves which may be used to correct observed widths under circumstances where the Lorentz shape may be verified and effects of finite modulation frequency may be ignored.

538.56

1226 A METHOD FOR THE MEASUREMENT OF THE NUCLEAR TRANSVERSAL RELAXATION TIME.

G.Bonera, L.Chiodi, L.Giulotto and G.Lanzi.

Nuovo Cimento, Vol. 14, No. 1, 119-34 (Oct. 1, 1959).

A method for measuring transverse relaxation times in liquids is described. The method is based on the observation of the decay of the nuclear magnetization when it precesses in a plane perpendicular to the constant magnetic field. This condition is realized by stopping the variation of the constant magnetic field during a fast adiabatic passage at a proper time. The constant magnetic field is modulated with a saw-tooth current from a relaxation oscillator and an amplifier. When the voltage induced by the nuclear precession reaches a fixed value the relaxation oscillator is stopped with a delay such that the constant field stops its variation at the value for which the signal has the largest amplitude. Measurements have been made on some pure liquids and the preliminary results indicate that the values of T_2 are very close to those of T_1.

538.56

1227 DETAILS OF A 2.5 TO 5 mm RADIOSPECTROSCOPE.

A.I.Barchukov and A.V.Prokhindeev.

Radiotekhnika i Elektronika, Vol. 4, No. 7, 1173-79 (July, 1959). In Russian.

Describes and illustrates the construction of the frequency multiplier (separating the third harmonic from an 8 mm klystron), the pick-up head, the decoupler and the absorption cell. Frequency measurement and stabilization are described with block diagrams, the same 3 cm klystron being used as auxiliary oscillator in both cases.

D.E.Brown

NUCLEAR AND ATOMIC PHYSICS

APPARATUS . PARTICLE DETECTORS

539.1.07 : 535.37 : 539.2

FLUORESCENT RESPONSE OF CESIUM IODIDE CRYSTALS TO HEAVY IONS. See Abstr. 664

539.1.07

1228 THE SPREADING OF DISCHARGES IN QUENCHED COUNTER TUBES. K.H.Lauterjung and O.Vater.
Z. Naturforsch., Vol. 14a, No. 9, 805-9 (Sept., 1959). In German.

An experimental study of discharge propagation in argon-methylal filled Geiger counter tubes. Reference is made to discharge propagation by photon effects at both the anode wire and the cathode. J.D.Craggs

539.1.07

1229 SIMPLE PARALLEL PLATE IONIZATION CHAMBER FOR THE UNDERGRADUATE NUCLEAR PHYSICS LABORATORY. G.E.Bradley.
Amer. J. Phys., Vol. 28, No. 2, 163-4 (Feb., 1960).

539.1.07

1230 TRANSITION EFFECT FOR ELECTRONS IN WALLS OF AN IONIZATION CHAMBER. V.A.Dmitriev.
Zh. eksper. teor. Fiz., Vol. 35, No. 2(8), 553-4 (Aug., 1958). In Russian. English translation in : Soviet Physics-JETP (New York), Vol. 35 (8), No. 2, 382-3 (Feb., 1959).

The variation of the number of electrons in the transition of the electron-photon cascade, initiated by π^0 mesons, from the lead absorber into the iron wall of the chamber has been calculated as a function of wall thickness, taking into account the variation in range of low energy electrons due to their scattering. The result of the calculation is shown graphically. I.C.Demetsopoullos

539.1.07

1231 OPTICAL METHODS OF OBSERVING THE IONIZATION ALONG FAST PARTICLE TRACKS. V.V.Vladimirskii.
Zh. eksper. teor. Fiz., Vol. 35, No. 2(8), 556-7 (Aug., 1958). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 35(8), No. 2, 384-6 (Feb., 1959).

The possibility of direct observation of tracks without vapour condensation on ions is based on the fact that when excited atoms and ions produced along the tracks are illuminated by resonance light, the number of scattered photons is much greater than the number of photons recorded in a direct observation of scintillations in the gas. Calculation shows that for a time of observation $t = 0.03$ sec the number of photons from a single scattering ion is 2×10^3, the corresponding light intensity being within the limits of detection of a photoelectric device or, probably, of direct photographic recording in the case of heavily-ionizing particles. I.C.Demetsopoullos

539.1.07 : 535.8

1232 PROBLEM OF STEREOSCOPY IN THE BUBBLE CHAMBER. CORRECTION FOR REFRACTION. D.Nyagu [Neagu].
Rev.de Physique (Bucarest), Vol.4, No.2, 235-43 (1959). In Russian. Also in Stud. Cercetari Fiz., Vol.9, No.2, 241-9 (1958). In Roumanian.

Analyses the distortion of the image of a figure immersed in a transparent medium (refractive index n) and photographed in air with a small (about 10^0) angle of incidence. Correction formulae are given for coordinates, lengths and angles. F.Lachman

539.1.07

1233 PHOTOGRAPHIC METHOD OF DETECTION OF DENSE SHOWERS OF CHARGED PARTICLES. I.D.Rapoport.
Zh. eksper. teor. Fiz., Vol. 34, No. 4, 998-1000 (April, 1958). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 34(7), No. 4, 689-90 (Oct., 1958).

It is proposed to use a multiple sandwich of several layers of a scintillating material and photographic emulsion. Tests with P^{32} β-particles indicated that a minimum of $\sim 1.5 \times 10^4$ particles were necessary for detection. E.J.Burge

539.1.07 : 537.311.33 : 621.382.23

1234 GOLD-GERMANIUM JUNCTIONS AS PARTICLE SPECTROMETERS. J.M.McKenzie and D.A.Bromley.
Proc. Instn Elect. Engrs, Paper 2992 [International Convention on Transistors and Associated Semiconductor Devices] publ. 1960 (Part B Suppl. No. 16, 731-4).

Gold—germanium p-n junctions for the detection of α-particles and fission fragments are reported in the references. The present investigation, using protons, deuterons, α-particles and He^3 ions, shows that the output pulse is proportional to the incident energy, providing the particle range does not exceed the effective junction thickness. Measurements on the maximum pulse heights obtainable from protons and deuterons agree on the effective junction thickness; however, the exact value varies with method and conditions of manufacture and increases with the voltage across the junction. The output pulse height is not dependent on the type of particle provided the junction bias is maintained above the minimum value (about 1 volt) required to prevent recombination. The pulse height is independent of crystal temperature if the voltage on the crystal is fixed, but as the temperature decreases the signal/noise ratio increases. At liquid-nitrogen temperature the resolution of 5 MeV α-particles (2-3%) is not determined by the signal/noise ratio. A value of 2.84 ± 0.12 eV, in accord with that previously reported, has been found for the energy required to produce an electron-hole pair in germanium. Pulse rise times have been shown to be less than 3 millimicrosec and are believed to be much shorter than this. Applications of these detectors in charged-particle spectroscopy are discussed.

539.1.07 : 539.17

180^0-FOCUSING PAIR SPECTROMETER. See Abstr. 459

539.1.07

1235 INVESTIGATION OF A MODEL OF A MAGNETIC β-SPECTROMETER WITH PERMANENT MAGNETS. T.Kalnin'.
Latv. PSR Zinat. Akad. Vestis, No.7 (144), 49-56 (1959). In Russian.

The point of chief interest is the uniformity of the magnetic field. Methods of improving this include alternate cyclical magnetization, careful alignment of pole-faces by means of brass spacers, and the use of temporary shims (while magnetization is in progress). The influence of particles of high coercive force on the magnetic circuit is also considered. A.E.I.Research Laboratory

539.1.07

1236 CALCULATION OF THE EFFICIENCIES OF LEAD CONVERTERS. V.M.Mal'tsev.
Pribory i Tekh. Eksper., 1959, No. 1, 28-32 (Jan.-Feb.). In Russian.

The efficiencies of lead converters in the thickness range 0.1 to 0.7 cm are calculated, for photons of energy 50 to 500 MeV. Multiple scattering is taken into account. J.W.G.Wignall

NUCLEAR FIELD THEORY

539.11

1237 MATHEMATICAL PROBLEMS OF QUANTUM FIELD THEORY. [Les problèmes mathematiques de la théorie quantique des champs].
Paris: Centre National de la Recherche Scientifique (1959) 183 pp. [Colloques Internationaux du Centre National de la Recherche Scientifique No. 73]. In French.

Twelve papers presented at an international conference at Lille, 3-8 June, 1957. Abstracts will be found under the appropriate headings in this or succeeding issues of "Physics Abstracts".

539.11

1238 ON THE PHASE FACTORS IN INVERSIONS. G.Feinberg and S.Weinberg.
Nuovo Cimento, Vol. 14, No. 3, 571-92 (Nov. 1, 1959).

The phase factors which can appear in the definition of the inversions, C, P, T and their products are discussed. It is shown that because of the existence of "physically equivalent" Hamiltonians, the phases in C, CP, T and TP for complex fields are unmeasurable. For the remaining inversions it is possible to construct interactions which require more general phases for complex fields than the usual ± 1, $\pm i$, when and only when the theory contains certain discrete multiplicative symmetries. Examples of such interactions are given.

539.11

1239 ELECTROMAGNETIC CORRECTIONS TO ISOTOPIC SPIN CONSERVATION.

S.Weinberg and S.B.Treiman.
Phys. Rev., Vol.116, No.2, 465-8 (Oct. 15, 1959).

If electromagnetic interactions are wholly responsible for all departures from isotopic spin invariance, then the strict conservation law $\Delta T = 0$ may be replaced, to order e^2, by the rule $|\Delta T| \leqslant 2$. Consequences of this weaker restriction are discussed for elementary particle masses, scattering processes, and weak-interaction decay processes. The apparent absence of particles with isotopic spins greater than one makes it difficult to find very practical experimental tests of this rule.

539.11

1240 THE METHOD OF QUASI-REAL PROCESSES IN QUANTUM ELECTRODYNAMICS.

P.Kessler.
C.R. Acad. Sci. (Paris), Vol. 249, No. 21, 2162-4 (Nov. 23, 1959).
In French.

Proposes the following approximation. When a Feynman diagram contains a vertex at which a highly relativistic fermion is scattered with the emission of a photon, the contribution of this vertex is calculated as for a real process. R.J.N.Phillips

539.11

1241 ON THE POSSIBLE EXISTENCE OF A DERIVATIVE COUPLING IN QUANTUM ELECTRODYNAMICS.

F.A.Kaempffer.
Canad. J. Phys., Vol. 37, No. 12, 1339-43 (Dec., 1959).

Within the framework of quantum electrodynamics there exists the possibility of a derivative coupling between source and photon field, referred to as $e\Lambda$-charge, which has no classical analogue. For calculations the usual graph technique can be used, provided the factor $e\gamma_\mu$ contributed by each vertex in a conventional graph is replaced by $ie\Lambda k_\mu$, where Λ is a length characteristic of the new interaction. Using as cutoff the nucleon mass M one finds for a bare source of electronic mass m the self-energy in second order to be $\Delta m/m \cong 200$, if $\Lambda^{-1} \cong 60$ M. It is argued that the large mass difference between muon and electron may be due to this effect, assuming muon and electron to differ only in that the muon has $e\Lambda$-charge whereas the electron has not. An estimate is made of the muon—muon scattering cross-section caused by the presence of $e\Lambda$-charge on the muon, and it is found that the existance of this derivative coupling may have escaped observation.

539.11

1242 GAUGE DEPENDENCE OF THE WAVE-FUNCTION RENORMALIZATION CONSTANT IN QUANTUM ELECTRODYNAMICS.

K.Johnson and B.Zumino.
Phys. Rev. Letters, Vol. 3, No. 7, 351-2 (Oct. 1, 1959).

It is shown that there is a general relation between the wave-function renormalization constants for a class of "manifestly" covariant gauges. In the case of a cutoff theory whose limit is local electrodynamics, at most one gauge can have a finite and non-vanishing renormalization constant. The infinite factor for the other gauges is related to the behaviour of longitudinal and scalar quanta and has no relevance to the consistency of the unrenormalized theory. The choice of such a cutoff gauge to discuss low energy phenomena is discussed. R.F.Peierls

539.11

1243 MULTIPOLE SINGULARITIES OF CLASSICAL VECTOR AND PSEUDOVECTOR FIELDS.

P.Havas.
Phys. Rev., Vol. 116, No. 1, 202-17 (Oct. 1, 1959).

The general form of the equations of motion of a particle possessing multipole singularities of a neutral vector or pseudovector meson field has been found by Harish-Chandra (Abstr. 1498 of 1946) under the assumption of a divergence-less current. In a recent paper (Abstr. 4282 of 1959) a more general form of the interaction was proposed, and the equations of motion were found for this case for neutral, charged and charge-symmetric fields. Here the author establishes forms of the multipole moments of arbitrary order campatible with these equations, and also of the moments compatible with the more restrictive interactions proposed by Harish-Chandra, which include those of electrodynamics as a special case; they are established under the assumption that the spin of the particle is of constant magnitude and has only spatial components in the rest system, and for pure 2^n-pole moments of constant magnitude ("intrinsic moments") or of variable magnitude ("induced moments", acceleration-dependent forces). In an appendix the results of the previous paper on singularities of scalar and pseudoscalar fields, which established the general form of the intrinsic moments, are generalized to show the possibility of induced moments of all orders, and it is shown that a particle can carry an arbitrary linear combination of multipole singularities of spin-zero and one fields.

539.11

1244 ON THE TRANSFORMATION PROPERTIES OF STRONG INTERACTIONS.

N.Dallaporta and T.Toyoda.
Nuovo Cimento, Vol. 14, No. 1, 142-60 (Oct. 1, 1959).

By extending the procedure outlined in previous papers of grouping several baryon states to form many-component spinors obeying symmetry properties which are not apparent for the separate states, a general Dirac equation satisfied by a 32-component spinor including all the known baryon states is proposed and its properties are discussed. The baryon states, apart from the normal space time coordinates, are described by two kinds of independent internal parameters: the isospin variables and the hypercharge variables. The K interactions are expressed by two independent terms with two different interaction constants F and F', each of which is invariant for rotations in a 4 dimensional hypercharge space, and the pion interactions by the usual expression invariant for rotations in a 3 dimensional isospin space, quite independent from the hypercharge space; and finally electromagnetic interactions are formulated by the combination of two terms which allow to obtain the experimentally known charge labellings of the different baryon states when a two step separation process is applied to the equation, which leads for the K transitions to selection rules expressing naturally the conservation of hypercharge or strangeness as it is formulated in the doublet approximation. The combination of the two K interaction terms allows further to obtain two kinds of coupling constants F + F' and F − F' for the different interaction terms, disposed in such a way as to explain the observed different self masses of the baryons. It is further shown that the 32-component equation is invariant under boson, spinor and charge conjugation operations separately, which are rigorously valid even when the different baryon masses are included. Finally some aspects of the γ_5 transformation properties of the equation are discussed. The present approach seems therefore adequate to unify under few common points-of-view the treatment of the baryon states and to put into evidence some general invariance properties which otherwise would not be revealed.

539.11

1245 REGULARIZATION AND RENORMALIZATION. II. NECESSARY AND SUFFICIENT CONDITIONS.

E.R.Caianiello.
Nuovo Cimento, Vol. 14, No. 1, 185-210 (Oct. 1, 1959).

The analysis begun in Pt I (Abstr. 11810 of 1959) of the conditions under which the regularization, performed by the adoption of the modified integrals introduced there, acts as a renormalization is completed. The "conditions of the second type" announced in Pt I are formulated and discussed; a quantitative analysis may give results different from the standard requirements for renormalizability: as an example, it is shown that the neutral scalar meson theory is not renormalizable, contrary to current belief. The Lie equations of the renormalization group can be derived without difficulty, and their integrability conditions investigated. Finally, it is shown that using the modified integrals amounts to solving the differential branching equations for kernels under the condition that the solutions belong to a certain well-defined mathematical class $\mathcal{K}$. In this way, ultraviolet infinities never appear, and the search for the renormalizability conditions becomes a search for the self-consistence of a theory, which need be made once for all and cannot cause inconvenience in computations. The result is a rigorous mathematical formulation of the renormalized theory, which avoids all mentions of "bare particles", is completely rid of ambiguities and is suited both for practical computations and for the study of fundamental questions. The unphysical splitting of processes into Feynman graphs is avoided; the troubles due to overlaps are shown to have a trivial origin and are altogether eliminated; all vertex-part contributions vanish with this method, at least in electrodynamics, since the cancellation on them against electron self-energy contributions occurrs prior to actual computation. These criteria will be applied in a forthcoming work to an exhaustive study of electrodynamics; they are expected to play a relevant role in a search for consistent theories of elementary particles.

539.11

1246 ON SCALE TRANSFORMATIONS.

J.Wess.
Nuovo Cimento, Vol. 14, No. 3, 527-31 (Nov. 1, 1959).

Invariance against scale transformation has been used by

Heisenberg to define a lepton number. Some properties of this transformation are more easily investigated with scalar fields, the mass dependence of which is known. For the scalar fields and the harmonic-oscillator, some properties of the infinitesimal transformation are listed here.

539.11

1247 ON THE VARIATIONAL PRINCIPLE FOR SPINOR FIELDS. J.Winogradzki.

C.R. Acad. Sci. (Paris), Vol. 249, No. 9, 911-13 (Aug. 31, 1959). In French.

A discussion of the general structure of the Lagrange function for linear spinor equations of the form $m\psi + \gamma^k\psi_{,k} = 0$. R.A.Newing

539.11

1248 SOURCE DENSITY AND HUYGEN'S PRINCIPLE IN DIRAC'S ELECTRON THEORY. Phan-Van-Loc.

C.R. Acad. Sci. (Paris), Vol. 249, No. 16, 1467-8 (Oct. 19, 1959). In French.

A new derivation of some formulae which were obtained in a previous paper (Abstr. 1037 of 1954). The new treatment is simpler and gives a clearer physical interpretation. P.M.Davidson

539.11

1249 GREEN'S FUNCTIONS FOR ELEMENTARY PARTICLES. H.Ezawa and H.Umezawa.

Phys. Rev., Vol. 116, No. 2, 463-5 (Oct. 15, 1959).

Harris (Abstr. 3130 of 1959) raised an objection against the authors' work [Quantum Field Theory, Amsterdam : North-Holland Publishing Company (1956)] on the general structure of the Green's function for particles of arbitrary spin. Reasons are given why his objection is not valid.

539.11

1250 ANOMALOUS MAGNETIC MOMENTS OF BARYONS IN A STATIC PERTURBATION THEORY. W.G.Holladay.

Phys. Rev., Vol. 115, No. 5, 1331-4 (Sept. 1, 1959).

A universal coupling between pions and baryons should lead to anomalous moments comparable in magnitude for all the baryons except for the Λ and Σ^0 whose anomalous moments for reasons of isotopic spin symmetry should receive no direct contribution from the pion field. To estimate the influence of the K-mesonic field on these moments, a static, cut-off, second-order perturbation calculation is made on the assumption that all baryons have spin $\frac{1}{2}$ and the same parity, that the K-meson is a pseudoscalar, and that the K-mesonic interaction with the baryons is charge independent. Along the same lines a fourth-order calculation of the pionic contributions to these moments is also made. Baryon currents are neglected in these calculations and cut-off momenta based on the rest mass of the baryon emitting the meson were uniformly used for all processes. The Λ and Σ^0 moments are negative with a value of only about 0.5 nuclear magnetons even if the K-meson coupling constants are large and judiciously chosen, a value which is therefore indicated as an upper limit, if no special enhancement effect is considered. If the K-meson couplings are all considerably smaller than the universal pion baryon coupling, then the Λ and Σ^0 moments are quite small but the other hyperons have moments of comparable magnitude as is generally to be expected. If all K-coupling constants are large, our considerations show that p, n, Σ^+, and Ξ^- may still have comparable anomalous moments but the Σ^- is indicated to have a somewhat larger and the Ξ^0 a somewhat smaller moment than these. A pion coupling to the hyperons different from that to the nucleons would manifest itself in characteristic ways in terms of anomalous magnetic moments, for large or small values of the K-coupling constants.

539.11

1251 DISPERSION RELATIONS AND PERTURBATION THEORY. O.I.Zav'yalov.

Dokl. Akad. Nauk SSSR, Vol. 128, No. 2, 273-5 (Sept. 11, 1959). In Russian.

In recent works of Nambu (Abstr. 872 of 1953) and Simanzik (1958) the analytic properties of the scattering amplitudes have been studied in the so-called α-representation with the help of the majorant-method. In this method, however, a precious part of the available information is lost. This and other difficulties can be remedied by combining perturbation theory with the general theory of dispersion relations. The method is illustrated on the example of the forward scattering of K-mesons on nucleons. P.Roman

539.11

1252 THE FIELD THEORETIC DEFINITION OF THE NUCLEAR POTENTIAL. I. J.M.Charap and S.P.Fubini.

Nuovo Cimento, Vol. 14, No. 3, 540-59 (Nov. 1, 1959).

It is shown that the static limit ($\mu/M \to 0$) leads to completely unreliable results in a perturbation theory definition of the potential, even in graphs without elastic scattering intermediate states. However, it is still possible to define a potential which is an energy-independent function of r alone, which when inserted into a non-relativistic Schrödinger equation reproduces the relativistic field-theoretic scattering matrix at sufficiently low energies. A method is developed whereby such a potential, in which both μ and M occur as parameters, is defined unambiguously for the case of a proton and a neutron scattering through a neutral meson field. By using dispersion relations for proton—neutron scattering, it is concluded that the potential reproduces the scattering matrix for momenta $\ll \sqrt{M\mu}$. Finally, a general method for explicit construction of the potential as a superposition of Yukawa potentials of different masses is proposed, and the one- and two-meson exchange contributions to the potential are evaluated.

539.11

1253 PROPAGATION OF VECTOR WAVES IN NON-LINEAR MESON DYNAMICS. V.I.Skobelkin.

Dokl. Akad. Nauk SSSR, Vol. 128, No. 3, 514-16 (Sept. 21, 1959). In Russian.

The general form of the covariant non-linear field equations for an interacting vector field with non-vanishing mass are given and the velocity of the propagation of signals calculated. There are, in the general case, four different velocities, corresponding to different polarizations. The unique Lagrangian corresponding to a field such that the waves have no double refraction and polarization in directions perpendicular to the collinear E and H fields is found. P.Roman

539.11

1254 MESON—MESON SCATTERING TERM IN PSEUDOSCALAR—PSEUDOSCALAR MESON THEORY.

M.Sugawara and A.Kanazawa.

Phys. Rev., Vol. 115, No. 5, 1310-17 (Sept. 1, 1959).

The meson—meson scattering term is investigated within the static approximation for a nucleon. First a static Hamilton is constructed from the renormalizable covariant meson theory in a manner similar to that proposed by Sugawara, [Progr. theor. Phys., Vol. 18, 383 (1957)]. Improvements are that the meson—meson scattering term is included besides the pseudoscalar—pseudoscalar coupling term and that an argument is presented to show that the Foldy transformation is the unique one generating a valid static Hamiltonian, though it was left undetermined before. The resulting static Hamiltonian is then analysed, for the cases of low-energy S- and P-wave pion—nucleon scattering and threshold photomeson production, in terms of the one-meson approximation of the Chew—Low—Wick formalism, without recourse to perturbation expansion. It is shown in particular that the meson—meson scattering term modifies the Chew—Low effective range plot of the δ_{33}-phase shift, making the renormalized P-wave coupling constant smaller than the conventional plot gives, for a positive coefficient of the meson—meson scattering term in the Hamiltonian. Empirical values of the coupling constant determined through the conventional Chew—Low plot and threshold photomeson extrapolation are shown to be interpretable in terms of the renormalized P-wave coupling constant of 0.08 and the meson—meson scattering term with a coefficient of $\cong + 4$ ($h = c = 1$). The present treatment of threshold photoproduction of mesons, however, does not agree with the relativistic dispersion relation. General features of the static model resulting from the ps—ps meson theory are summarized, together with the conclusions obtained. The effects of strange particles and of renormalization are neglected.

539.11 : 539.17

1255 MATHEMATICAL ANALYSIS OF A SIMPLE MODEL RELATED TO THE STRIPPING REACTION.

E.Lieb and H.Koppe.

Phys. Rev., Vol. 116, No. 2, 367-71 (Oct. 15, 1959).

A scattering process in which an incoming bound particle can split up into its component parts when its total energy is above a threshold is of considerable interest physically (deuteron stripping, etc.) and mathematically (analytic properties of the S-matrix, etc.). For such complicated problems it is obviously convenient to have a simple, analytically soluble model for reference, but although many models have been suggested in the past none have proved analytically tractable. In this paper is proposed and completely solved a one-dimensional model which, although it is not very physical, has all the desired characteristics. The problem is not mathematically trivial, however, and leads to a Wiener—Hopf integral equation.

539.11

1256 ANALYTIC PROPERTIES OF TRANSITION AMPLITUDES IN PERTURBATION THEORY. S.Mandelstam.
Phys. Rev., Vol. 115, No. 6, 1741-51 (Sept. 15, 1959).

The analytic properties of two-particle transition amplitudes as functions of both energy and momentum transfer are examined in perturbation theory. The modified Nambu representation previously proposed by the author (Abstr. 4941 of 1959) for expressing these properties is discussed in a little more detail. It is shown that, as long as the masses do not satisfy certain inequalities connected with the existance of anomalous thresholds, the fourth-order terms, calculated in the usual manner, satisfy the representation. The spectral functions are calculated explicitly for spinless particles. The proof can be extended to the sixth order, but is not worked out here. The modifications necessary when there exist anomalous thresholds are mentioned. (See also following abstract).

539.11

1257 CONSTRUCTION OF THE PERTURBATION SERIES FOR TRANSITION AMPLITUDES FROM THEIR ANALYTICITY AND UNITARITY PROPERTIES. S.Mandelstam.
Phys. Rev., Vol. 115, No. 6, 1752-62 (Sept. 15, 1959).

The analyticity properties of transition amplitudes are used in conjunction with the unitarity requirements to generate successive terms in the perturbation series, without referring to a specific Lagrangian. In the sixth and higher orders, production is neglected in the unitarity condition; subject to this approximation, it is found that the series can be so constructed. No analyticity properties which have not been rigorously proved need be employed, and the terms are found to satisfy the double dispersion representation. By examining the connection between this method and the conventional calculation of the perturbation series, the types of spectral function corresponding to different Feynman diagrams can be found. Formulae are given for the regions in which the spectral functions are nonzero.

ELEMENTARY PARTICLES

539.12

1258 TWO PROPOSED EXPERIMENTS FOR THE DETECTION OF THE DIRAC MONOPOLE. R.Katz and D.R.Parnell.
Phys. Rev., Vol.116, No.1, 236-7 (Oct. 1, 1959).

A magnetic monopole may be detected by its deflection in an electric field or by the character of the ionization it produces. The electric deflection experiment may be performed in a helium bubble chamber where helical (or spiral) tracks whose axes are parallel to the D-lines would be certain evidence for the discovery of the monopole. Previous studies of the ionization have emphasized that the Bragg tail would be missing from a monopole track, as compared to a charged particle. This conclusion must be modified because of the thin-down of tracks of heavy nuclei. The tracks of heavy nuclei thicken up and then thin down as they approach the end of their range. The tracks of monopoles are wedge-shaped, thinning down continuously as they approach the end of their range. Since the track width is due to knock-on electrons, or delta rays, any search for the monopole using this criterion must be conducted with electron-emulsions.

539.12 : 535.43

ABSORPTION AND SCATTERING COEFFICIENTS FOR A WEAKLY ABSORBING ISOTROPIC SCATTERING MEDIUM.
See Abstr. 1044

539.12

1259 ON THE COUPLING OF THE ELEMENTARY PARTICLES WITH THE ELECTROMAGNETIC FIELD. C.G.Bollini.
Nuovo Cimento, Vol. 14, No. 3, 560-70 (Nov. 1, 1959).

The author has proposed a theory in which all the supplementary conditions are considered as constraint equations imposed on the wave-function and implying that only $2s + 1$ (s = spin) of its components are really independent. In the previously treated free field case, all the elementary particles obey the Klein—Gordon equation of motion. To introduce the electromagnetic field in a general way a basic interaction involving the transformation matrix of the wave-function is considered. A process is described, by means of which a gauge invariant equation of motion can be constructed. The theory is renormalized and describes particles having the normal gyromagnetic factor 2 for any spin value.

539.12

1260 DETERMINATION OF ENERGIES OF RELATIVISTIC PARTICLES BY MEASUREMENT OF MULTIPLE COULOMB SCATTERING.
I.Ya.Chasnikov, Zh.S.Takibaev, and É.G.Boos.
Pribory i Tekh. Eksper., 1959, No. 1, 54-7 (Jan. - Feb.).
In Russian.

Description of method for determining energies of relativistic particles, eliminating "noise" by measurements with three different cell lengths. It is claimed that measurements on particles with energies up to 20 GeV are possible using a track length of 4-5 cm.
J.W.G.Wignall

539.12

1261 BINDING EFFECT CORRECTIONS IN THE ENERGY-LOSS DISTRIBUTION FUNCTIONS FOR CHARGED PARTICLES PASSING THROUGH THIN ABSORBERS.
W.Rosenzweig.
Phys. Rev., Vol. 115, No. 6, 1683-6 (Sept. 15, 1959).

In the theoretical treatment of the statistical fluctuation in energy-loss of charged particles passing through thin absorbers, terms which are of the order of the electron binding energy are ordinarily neglected. The corrections required, when this is no longer justified, are discussed in particular reference to the development by Symon, which has as its limiting cases the Gaussian distribution derived by Bohr, and Landau's distribution. Formulae are presented which give the correction for each of the three weighted parameters appearing in Symon's derivation. The corrected parameters can then be used in conjunction with Symon's curves to obtain the energy-loss distribution appropriate for a given set of conditions. An illustration is presented for the cases of 5 MeV protons and 5 MeV α-particles.

Photons

539.12

1262 THE EFFECTIVE ENERGY OF THE Ra GAMMA RAYS (FILTERED BY 0.5 mm PLATINUM).
Y.Moriuchi, K.Kawashima and T.Yagi.
Bull. Electrotech. Lab. (Tokyo), Vol. 22, No. 10, 769-84 (Oct., 1958).

Relative dose rates of γ-rays from Ra^{226} and its products are calculated as a function of distance from the source, and are shown to agree with experiment at least up to 20 metres. The definition of the effective γ-ray energy is discussed, and determined as 1.3 MeV for Ra.
A.E.I. Research Laboratory

539.12

1263 A PROPOSAL OF A GAMMA-SOURCE WITH IMPROVED HOMOGENEITY OF RADIATION FIELD.
K.Hukuda.
Mem.Fac.Sci. Kyusyu Univ. B, Vol.2, No.5, 171-3 (Dec., 1958).

A proposed arrangement for improving the homogeneity of the gamma ray flux from a cylindrical source, by dividing it into two equal lengths with a space between, is discussed mathematically. The flux distribution is calculated for several values of the separation between the two cylinders.
A.E.I.Research Laboratory

539.12

1264 AUTOMATIC γ-RAY SPECTROMETER.
M.Frank.
R.C. Ist. Super Sanita, Vol. 22, Pt 8-9, 884-9 (1959).

A single channel γ-ray spectrometer is described. The number of pulses counted on each channel is automatically recorded on a paper ribbon, and the apparatus is then ready for measuring the next channel.

539.12

1265 SPECTRAL DISTRIBUTION OF BREMSSTRAHLUNG FROM AN IONIZED GAS. M.S.Sodha.
Canad. J. Phys., Vol. 37, No. 12, 1380-3 (Dec., 1959).

Using Heitler's and Sommerfeld's cross section the spectral distribution of bremsstrahlung from an ionized gas has been calculated, neglecting self-absorption and stimulated emission. These results can be used to calculate the spectral distribution of bremsstrahlung from a mass of ionized gas, considering self-absorption and stimulated emission if one utilizes the expression obtained by Allen and Hindmarsh.

539.12

1266 CALCULATION OF THE BREMSSTRAHLUNG RADIATION FROM AN EXTREMELY RELATIVISTIC PARTICLE BY THE METHOD OF QUASI-REAL PROCESSES.
P.Kessler.
C.R. Acad. Sci. (Paris), Vol. 249, No. 22, 2298-300 (Nov. 30, 1959). In French.

It is shown how the method of quasi-real processes allows the bremsstrahlung cross-section of an extremely relativistic fermion to be related to the elastic scattering cross-section. The result is the same as that obtained by approximation from the Bethe—Heitler formula. R.F.Peierls

539.12

1267 CHERENKOV RADIATION OF LONGITUDINALLY POLARIZED ELECTRONS.
A.A.Sokolov and Yu.M.Loskutov.
Zh. eksper. teor. Fiz., Vol. 34, No. 4, 1022-3 (April, 1958). In Russian. English translation in : Soviet Physics—JETP (New York), Vol. 34(7), No. 4, 706-7 (Oct., 1958).

The radiation has been shown to consist of a linearly polarized classical part, an unpolarized quantum part proportional to $\hbar^2$, and a longitudinally polarized contribution proportional to $\hbar$. D.W.L.Sprung

539.12 : 537.56

1268 OCCURRENCE OF VAVILOV—ČERENKOV RADIATION IN A HIGH-TEMPERATURE PLASMA. J.Neufeld.
Phys. Rev., Vol. 116, No. 1, 1-3 (Oct. 1, 1959).

Akhiezer and Sitenko (Abstr. 3329 of 1953) investigated the energy loss of a charged particle moving through a plasma at a velocity considerably lower than the mean thermal velocity of the electrons in the plasma and determined the component of the stopping power due to the transverse electric field produced by the plasma and acting upon the particle. The presence of such a component may in some instances be associated with the occurrence of the Vavilov—Cherenkov radiation. It is shown, however, that in this particular case the field surrounding the particle decreases very rapidly with the distance from the particle and no radiation takes place.

Neutrinos

539.12

1269 NON-CONSERVATION OF PARITY IN PROCESSES OF NEUTRINO CAPTURE BY PROTONS AND DEUTERONS.
V.V.Anisovich and A.A.Ansel'm.
Zh. eksper. teor. Fiz., Vol. 34, No. 4, 995-7 (April, 1958). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 34 (7), No. 4, 686-8 (Oct., 1958).

Assuming that the neutrinos have only longitudinal polarization, expressions are given for the capture rate as a function of the target polarization and the initial and final momenta, with a general parity non-conserving interaction. J.C.Taylor

Electrons

539.12

1270 X-RAY EVIDENCE FOR THE "POINT-STRUCTURE" OF ELECTRONS. R.Hosemann.
Z. Phys., Vol. 154, No. 4, 389-407 (1959). In German.

Analysis of the results of measurements (by other workers) of X-ray scattering by gases, in terms of the quantum-mechanical model of the atom, leads to experimental verification that the electron behaves as a charge-cloud whose diameter is less than the Compton wavelength, 0.024 A. A.R.Stokes

539.12

1271 MEASUREMENT OF IONIZATION OF 250 keV POSITIVE AND NEGATIVE ELECTRONS IN A HYDROGEN CLOUD-CHAMBER. L.Wiedecke.
Z. Phys., Vol. 154, No. 2, 150-9 (1959). In German.

An attempt is made to distinguish between positive and negative electrons by measurement of their primary and average ionization under standard conditions. Results obtained show that this is not possible under the conditions of the experiment but data on the primary ionization corrected to hydrogen are in agreement with previous work. A correction formula for mutual overlap of the track photographs is developed; to compare the theoretical and experimental values of the average ionization, an estimate for the clogging of the tracks is made and the results applied to the present case. S.J.St-Lorant

539.12

1272 DOUBLE SCATTERING OF ELECTRONS WITH A DIPOLE MOMENT. M.H.Zaidi.
Phys. Rev. Vol. 116, No. 2, 241-3 (Oct. 15, 1959).

The experiments of Obenshain and Page (Abstr. 3735 of 1959) have suggested the possible existence of a small electric dipole moment for an electron. Here the double scattering of electrons with a small intrinsic electric dipole moment is investigated theoretically for the case where magnetic and electric fields are present in the space between the two targets. It is shown by using density matrix techniques that the plane of polarization of the electron beam, after the first scattering, would be rotated by the magnetic and electric fields just as predicted by regarding the electrons as classical spinning tops with magnetic moments and classical electric dipoles precessing about the directions of the magnetic and electric fields, respectively.

539.12

1273 ORIGIN OF THE CHARACTERISTIC ELECTRON ENERGY LOSSES IN MAGNESIUM.
C.J.Powell and J.B.Swan.
Phys. Rev., Vol. 116, No. 1, 81-83 (Oct. 1, 1959).

The characteristic electron energy loss spectrum of magnesium was measured by analysing the energy distribution of 750, 1000, 1505 and 2020 eV electrons scattered by an evaporated specimen through 90°. The spectra were similar in form to those previously obtained with aluminium targets, in that the observed loss peaks were composed entirely of combinations of two elementary energy losses. These two losses, of magnitude 7.1 and 10.6 eV, were identified, respectively, with the lowered plasma loss proposed by Ritchie (Abstr. 7154 of 1957) and the plasma loss proposed by Bohm and Pines (Abstr. 2688 of 1952).

539.12

1274 POSITRON ANNIHILATION IN HELIUM.
T.B.Daniel and R.Stump.
Phys. Rev., Vol. 115, No. 6, 1599-600 (Sept. 15, 1959).

Positron mean lives were measured in helium gas over a wide temperature range at densities from 4.6 to 534 times the s.t.p. density and in liquid helium at 4.2 and 5.1°K. The orthopositronium mean life in the liquid at 5.1°K was found to be $(9.4 \pm 0.6) \times 10^{-8}$ sec which differs little from the lifetime in liquid at 4.2°K. Except at very low temperatures, the pick-off rate in gas agreed moderately well with theory. The low pick-off rate associated with orthopositronium in liquid was observed also in the gas at temperatures below 9°K for densities greater than 250 times the s.t.p. density.

Nucleons

539.12

1275 THE PROTON—NEUTRON MASS-DIFFERENCE ACCORDING TO MESON-THEORY.
L.O'Raifeartaigh, B.Średniawa and C.Terreaux.
Nuovo Cimento, Vol. 14, No. 2, 376-96 (Oct. 16, 1959).

The proton—neutron mass difference is calculated assuming that it is due to a mixed mesic-electromagnetic self-energy. The self-energies of the proton and neutron are calculated in the e^2f^2 approximation on grounds of meson theory both for ps and pv coupling. To make these finite the form factor suggested by Arnous and Heitler is applied to all three (nucleon—meson, nucleon—photon, and meson—photon) interactions. It corresponds to a cut-off of the virtual momenta at K (of the order M = nucleon mass), when the particle is at rest and is therefore a generalization of the extended source model. To carry through the otherwise extremely complicated calculation a further crude approximation is made, namely an expansion ~ 1/M. For both couplings the correct sign is obtained but in the ps case the result is too small by a factor 100. In the pv case the correct order of magnitude is obtained but the numerical value is still too small (by a factor of at least 5 or so) to overcompensate the purely electromagnetic self-energy of the proton. A comparison with the earlier work of Feynman and Speisman shows that the latter is not in agreement with the results of meson theory.

Protons

539.12

1276 NEUTRON SPECTRA FROM THE p + d REACTION. C.Wong, J.D.Anderson, C.C.Gardner, J.W.McClure and M.P.Nakada.
Phys. Rev., Vol. 116, No. 1, 164-6 (Oct. 1, 1959).

The energy and angular distributions of neutrons from the $p + d \rightarrow n + p + p$ reaction were measured for incident protons of energy 6.06, 7.15, 8.90, and 13.5 MeV. The peak in the neutron spectra near the maximum neutron energy is in qualitative agreement with the calculations of Heckrotte and MacGregor (Abstr. 2778 of 1959).

539.12

1277 CHARGE INDEPENDENCE IN THE REACTIONS $p + d \rightarrow \pi^0 + He^3$ AND $p + d \rightarrow \pi^+ + H^3$ AT 450 MeV. A.V.Crewe, E.Garwin, B.Ledley, E.Lillethun, R.March and S.Marcowitz.
Phys. Rev. Letters, Vol. 2, No. 6, 269-70 (March 15, 1959).

A previous experiment to test charge independence by measuring the ratio of the two cross-sections (Abstr. 6544 of 1957) was improved by counting the heavy particles emitted when protons from an external cyclotron beam hit a polymerized CD_2 target of 0.8 mm thickness. The heavy particles were momentum-analysed and identified by pulse-height analysis. Taking CD_2-C differences the experiment was performed at laboratory angles from 8 to 13°. A weighted mean for the branching ratio $\sigma(H^3)/\sigma(He^3)$ of 1.91 ± 0.25 was obtained, compatible with the ratio of 2 predicted by charge independence.
E.G.Michaelis

539.12

1278 COMPENSATIONS IN ELECTRON EXCITATION EFFECTS IN p-p AND p-n SCATTERING.
M.deWit, C.R.Fischer and W.Zickendraht.
Proc. Nat. Acad. Sci. U.S.A., Vol. 45, No. 7, 1047-52 (July, 1959).

Theoretical. Calculations of multipole Coulomb excitation effects by methods like those of Abstr. 1660 (1959) show that the classical compensation of elastic and inelastic scattering effects carries over into this quantum mechanical treatment. See also Abstr. 12552 (1959).
J.Hawgood

539.12

1279 PROTON—PROTON INTERACTIONS AT 970 MeV. A.P.Batson, B.B.Culwick, J.G.Hill and L.Riddiford.
Proc. Roy. Soc. A, Vol. 251, 218-32 (May 26, 1959).

A 970 MeV proton beam was passed through a hydrogen-filled diffusion cloud chamber located in a pulsed magnetic field, and a total of 1029 proton—proton interactions observed. The cross-sections for the possible reactions, and the angular distribution for the elastic scattering, were determined. The effects of scanning losses on these quantities are discussed. The results from 273 events of the type $p + p \rightarrow n + p + \pi^+$, and 72 events of the type $p + p \rightarrow p + p + \pi^0$, were calculated in detail. They are compared with the predictions of the 'isobar' theory of pion production, in which it is postulated that the production of pions occurs through an intermediate state of isotopic spin $T = \frac{3}{2}$. The results for positive pion production are in good agreement with this hypothesis, and disagree markedly with the predictions of a purely statistical theory. The results for neutral pion production do not agree well with the predictions of the isobar theory. (See also following abstract).

539.12

1280 FURTHER STUDY OF PROTON—PROTON INTERACTIONS AT 970 MeV.
J.D.Dowell, E.C.Fowler, J.G.Hill, G.Martelli, B.Musgrave and L.Riddiford.
Nuovo Cimento, Vol. 14, No. 1, 235-9 (Oct. 1, 1959).

Previous results on the p—p interaction (see preceding abstract) were re-examined to detect assymetries due to polarization effects and nonconservation of parity in the π^+-meson production process. From 552 events it is concluded that the polarization of protons scattered elastically from protons is in the neighbourhood of $\frac{1}{3}$, but no evidence was obtained for failure of parity conservation in the measurements on 328 π^+ producing events. An attempt was made to obtain information about the angular momentum state of the pion—proton system on the basis of the isobar model, following a suggestion by Morpurgo. However, it was concluded that the method could not yield this information without further detailed calculations.
S.J.Goldsack

539.12

1281 PROTON—PROTON ELASTIC INTERACTIONS AT 930 MeV.
J.D.Dowell, W.R.Frisken, G.Martelli and B.Musgrave.
Proc. Phys. Soc., Vol. 74, Pt 5, 625-31 (Nov., 1959).

The elastic scattering of 930 MeV protons by protons present in a propane bubble chamber is investigated. The method of isolating elastic p—p events from background contaminations is discussed. An estimate is made of the scanning efficiency and the elastic cross-section is found, from track length measurements, to be 21.6 ± 2.5 mb, in good agreement with the values obtained by other authors. The angular distribution of the scattered particles is also given and compared with the predictions of two high energy models.

539.12

1282 PROTON—PROTON SCATTERING AT 90° FROM 28 TO 68 MeV. L.H.Johnston and Yung Su Tsai.
Phys. Rev., Vol. 115, No. 5, 1293-4 (Sept. 1, 1959).

Proton—proton scattering cross-sections were measured at 45° in the laboratory system, from 28 to 68 MeV, with an accuracy of about ±1.2%. These measurements fill the energy gap between the work of Cork (Abstr. 1875 of 1951) on the low-energy end, and that of Kruse, Teem and Ramsey (Abstr. 2192 of 1956) at higher energies. In the region of overlap with these experiments there is reasonable agreement. The cross-section falls monotonically with increasing energy.

539.12

1283 ENERGY DETERMINATION FROM MULTIPLE MESON PRODUCTION BY 6.3 BeV PROTONS IN NUCLEAR EMULSION. P.L.Jain and H.C.Glahe.
Phys. Rev., Vol. 116, No. 2, 458-60 (Oct. 15, 1959).

864 stars produced by the 6.3 BeV proton beam of the Berkeley bevatron were observed in nuclear emulsion. The average number of shower particles was 2.7 prongs per star. The energy of the primary particle was determined by three different methods: (a) the median angle method; (b) Castagnoli's method; (c) Cocconi's graphical method. It is found that the results of these three methods are in good agreement with each other and are high in each case by a factor of 2.

Neutrons

539.12 : 539.17

1284 MULTILAYER PROBLEMS IN THE MULTIGROUP SPHERICAL HARMONICS METHOD. B.Davison.
Canad. J. Phys., Vol. 37, No. 12, 1482-98 (Dec., 1959).

In applying the spherical harmonics method to multilayer neutron transport problems it is necessary to invert certain matrices. It is already known that in the case of one-group theory for the problems with plane, spherical, or cylindrical symmetry, these inverse matrices can easily be written down explicitly, so that there is no need for numerical matrix inversion. In the present paper this result is extended to the case of multigroup theory.

Mesons

539.12

1285 ON THE QUESTION OF A ρ^0-MESON. Ya.I.Granovskii.
Zh. eksper. teor. Fiz., Vol. 36, No. 2, 623-4 (1959). In Russian.

The Fermi-Yang model of the π-meson as a tightly bound nucleon-antinucleon pair (Abstr. 2686/1950) indicates the possibility of an isotopic singlet meson, the ρ^0, provided the nucleon-antinucleon force is not too dependent on total isotopic spin. The model also implies a difference in mass between charged and neutral π-mesons, which was evaluated by Perel'man (Abstr. 13563 of 1959) as 12.7 electron masses. It is claimed that this will be brought closer to the experimental value of 9 electron masses by the inclusion of the magnetic interaction.
G.P.McCauley

539.12

1286 MESON PRODUCTION IN THE STATIC CHARGED-SCALAR THEORY. E.Kazes.
Nuovo Cimento, Vol. 14, No. 1, 74-80 (Oct. 1, 1959).

Meson production amplitudes in the charged-scalar theory are shown to satisfy integral equations which in the one meson approximation reduce to the Riemann—Hilbert boundary problem and the complete solution is given.

539.12

1287 ON THE VALIDITY OF THE EXPONENTIAL LAW FOR THE DECAY OF AN UNSTABLE PARTICLE.

M.Lévy.

Nuovo Cimento, Vol. 14, No. 3, 612-24 (Nov. 1, 1959).

The departure from the exponential decay law of an unstable particle is discussed, with the help of the Lee model, starting from an initial state which is a general superposition of eigenstates of the Hamiltonian. It is shown that the aymptotic behaviour and the magnitude of the additional terms are strongly affected by the production mechanism; although they can never vanish exactly, these terms can be made arbitrarily small by an appropriate preparation of the initial state. A possible generalization of this result is discussed.

539.12

1288 THE INTERACTION OF K-MESONS, PIONS, NUCLEONS AND HYPERONS.

V.S.Barashenkov.

Zh. eksper. teor. Fiz., Vol. 34, No. 4, 1016-17 (April, 1958).
In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 34(7), No. 4, 701-2 (Oct., 1958).

Evidence is adduced from the multiple production of strange particles in high-energy nucleon—nucleon collisions that (a) K-mesons interact less strongly with nucleons that pions do; (b) hyperons interact strongly with pions and nucleons. Gell-Mann's symmetric interaction gives satisfactory agreement with experiment. P.K.Kabir

539.12

1289 A METHOD OF ANALYSIS OF EVENTS INVOLVING MULTIPLE MESON PRODUCTION.

H.Huzita.

Nuovo Cimento, Vol. 14, No. 3, 484-92 (Nov. 1, 1959).

A method is proposed for evaluating the primary energy in events which lead to multiple meson production. It is shown that, in principle, K-mesons could be distinguished from π-mesons if sufficient statistics were available. Several published events are analysed by this method and the results are compared with several theories.

539.12

1290 ON THE DETERMINATION OF THE MEAN LIFE OF μ^- MESONS IN Ca AND Pb.

A.A.Quaranta, U.Dore and F.Pieraccini.

Nuovo Cimento, Vol. 14, No. 1, 48-53 (Oct. 1, 1959).

The results of a series of measurements for the determination of the apparent mean life of μ^--mesons in Ca and Pb, carried out by means of a recently described apparatus are reported (see Abstr. 1179 of 1958). The values obtained are $\tau = (35.7 \pm 3) \times 10^{-8}$ sec in Ca and $\tau = (7.3 \pm 0.6) \times 10^{-8}$ sec in Pb. The results are in agreement with those obtained by other investigators and with theoretical estimations.

539.12

1291 MEASUREMENT OF μ^+ LIFETIME.

J.Fischer, B.Leontic, A.Lundby, R.Meunier and J.P.Stroot.

Phys. Rev. Letters, Vol. 3, No. 7, 349-50 (Oct. 1, 1959).

A new accurate determination yielding a value 2.20 ± 0.015 μsec. S.J.Goldsack

539.12 : 537.59

POLARIZATION OF MU-MESON IN COSMIC RAYS.

See Abstr. 1327

539.12

1292 ENERGIES OF NEUTRONS FROM THE CAPTURE OF NEGATIVE μ-MESONS BY LEAD NUCLEI.

W.Ball and K.H.Lauterjung.

Z. Naturforsch., Vol. 14a, No. 5-6, 581-2 (May-June, 1959).
In German.

From the spectrum of recoil protons in paraffin it is concluded that the neutrons in the μ^- capture process are emitted with an energy not exceeding 3 Mev. S.J.St-Lorant

539.12

1293 PROPOSAL FOR DETERMINING THE ELECTROMAGNETIC FORM FACTOR OF THE PION.

W.R.Frazer.

Phys. Rev., Vol. 115, No. 6, 1763-72 (Sept. 15, 1959).

The possibility of measuring the electromagnetic form factor of the pion by extrapolation of the cross-section for $e^- + p \rightarrow n + \pi^+ + e^-$ was investigated. The method is based on the existence of a pole in the pion-electroproduction scattering amplitude as a function of the invariant momentum-transfer of the nucleon. The residue of this pole is the pion form factor multiplied by a known coefficient. Since the pole lies slightly outside the physical region of the invariant momentum transfer, an extrapolation of the experimental data is required. An approximate calculation of the pion electroproduction cross-section was made in order to estimate the experimental accuracy necessary for a significant extrapolation. Accuracy is required which is an order of magnitude better than that achieved at present in similar experiments.

539.12

1294 DECAY OF THE CHARGED PION.

R.F.Sawyer.

Phys. Rev., Vol. 116, No. 1, 231-5 (Oct. 1, 1959).

The amplitude for pion decay is related to quantities involved in the meson propagator under the strong π coupling alone. For pseudovector π coupling the Goldberger and Treiman result (Abstr. 5224 of 1958) follows under certain assumptions, but without an expansion in intermediate states. For pseudoscalar π coupling, similar, but somewhat inconsistent, results are obtainable by means of an equivalence relation applied to the weak interaction. An expansion in intermediate states of the absorptive part of the decay amplitude is related to a similar expansion for the meson propagator and in an approximation yields the Goldberger and Treiman result when states containing one nucleon pair and some number of pions are included

539.12

1295 ON THE INTERACTION OF 300 MeV NEGATIVE π-MESONS WITH THE NUCLEI OF NUCLEAR EMULSION.

B.Chemel.

C.R. Acad. Sci. (Paris), Vol. 249, No. 17, 1625-7 (Oct. 28, 1959).
In French.

The mean interaction length was found to be 26.8 ± 1.4 cm. The energy spectrum and differential cross-section were also considered. E.J.Burge

539.12

1296 CHARGE EXCHANGE SCATTERING OF 128 MeV NEGATIVE PIONS ON HYDROGEN.

E.Garwin, W.Kernan, C.O.Kim and C.M.York.

Phys. Rev., Vol. 115, No. 5, 1295-9 (Sept. 1, 1959).

The charge-exchange scattering of negative pions by liquid hydrogen was measured at 128 ± 2 MeV bombarding energy. A lead-glass Cherenkov counter was used to measure the energy spectrum of the gamma rays emitted in the decay of the neutral pions. The gamma rays were detected at four angles relative to the incident beam: 45^0, 80^0, 116^0 and 135^0. If the charge-exchange scattering cross-section is expanded as a sum of Legendre polynomials which are functions of the π^0 scattering angle in the centre-of-mass system, it is found that

$$\frac{d\sigma}{d\Omega}(\pi^-,\pi^0) = (1.00 \pm 0.04)\,[(2.04 \pm 0.06) +$$

$$+ (-1.61 \pm 0.13)P_1 + (1.43 \pm 0.024)P_2],$$

when only s and p waves are considered. The confidence level for the least-squares fit used to determine the coefficients inside the square brackets is 65%. The integrated cross-section is $\sigma_{tot}(\pi^-,\pi^0) = 25.6 \pm 1.3$ mb, which is in good agreement with other work.

539.12

1297 DETERMINATION OF THE PION—NUCLEON COUPLING CONSTANT FROM n—p SCATTERING ANGULAR DISTRIBUTION.

P.Cziffra and M.J.Moravcsik.

Phys. Rev., Vol. 116, No. 1, 226-30 (Oct. 1, 1959).

By the use of a method recently proposed by Chew (Abstr. 6022 of 1959), the pion—nucleon coupling constant is determined from differential cross-sections for neutron—proton scattering. Data at 90 and 400 MeV were used. Details of the extrapolation procedure are discussed and the statistical methods used in interpreting the results are explained. The resulting value of the coupling constant is between 0.06 and 0.07, depending on the range and energy of the data included in the analysis. The discrepancy between this value and the usually quoted 0.08 should not be taken seriously, however, because several nonstatistical uncertainties could not be taken into account. The origin of these uncertainties is discussed.

539.12

1298 ELASTIC SCATTERING OF 745 MeV/c NEGATIVE PIONS ON HYDROGEN. J.M.Gaillard, P.Lehmann, A.Lévêque, J.Meyer, D.Revel and J.Sacton.
C.R. Acad. Sci. (Paris), Vol. 249, No. 16, 1497-9 (Oct. 19, 1959).
In French.

The differential cross-section for π^-—p scattering was measured at the second resonance of the pion—proton spectrum. The total elastic cross-section was found to be $\sigma_t = 20 \pm 3$ mb.

S.J.St-Lorant

539.12

1299 DISPERSION ANALYSIS OF POSSIBLE PARITY NONCONSERVATION IN LOW-ENERGY PION—NUCLEON SCATTERING. S.Fubini and D.Walecka.
Phys. Rev., Vol. 116, No. 1, 194-202 (Oct. 1, 1959).

An attempt is made to analyse the possible parity nonconservation in low-energy pion—nucleon scattering. The use of relativistic dispersion relations enables such effects to be related to the possible parity nonconservation in strange-particle production from pion—nucleon collisions. It is shown that large violations of parity conservation in strange-particle production are indeed compatible with small effects in low-energy pion—nucleon scattering. It is suggested that this result might be useful in order to understand the very good evidence for parity conservation in nuclear physics.

539.12

1300 INVESTIGATION OF DISPERSION RELATIONS FOR THE PHOTOPRODUCTION OF PIONS.
A.M.Baldin and B.B.Govorkov.
Dokl. Akad. Nauk SSSR, Vol. 127, No. 5, 993-6 (Aug. 11, 1959).
In Russian.

Applying the method of the scattering dispersion relations, free from assumptions relating to special cases, the authors failed to eliminate contradictions between the theoretical and experimental values of the amplitudes of photoproduction. F.Lachman

539.12

1301 INTERFERENCE EFFECTS OF THE RETARDATION TERM IN PION PHOTOPRODUCTION. A.M.Wetherell.
Phys. Rev., Vol. 115, No. 6, 1722-6 (Sept. 15, 1959).

It is shown that the difference in behaviour of the high-energy (>450 MeV c.m.) total photoproduction cross-sections for π^+ and π^0 can be explained by the presence of the retardation term in the case of the π^+ production. The analogy with the behaviour at the $(\frac{3}{2}, \frac{3}{2})$ resonance is noted. The discussion naturally provides an explanation for the difference in centre-of-mass energies of the lower high-energy peak found in π^--p scattering and the corresponding peak in the π^+ photoproduction. It is felt that the discussion contributes some evidence for the resonance nature of the peaks.

539.12

1302 PARITY OF THE SECOND PION RESONANCE.
L.F.Landovitz and L.Marshall.
Phys. Rev. Letters, Vol. 3, No. 4, 190 (Aug. 15, 1959).

Stein (Abstr. 12557 of 1959) suggests that the second resonance at 700 MeV in the photoproduction of π^0-mesons in hydrogen has a negative parity. This conclusion is based on the assumption that it has a spin $J = \frac{3}{2}$ and that the observed strong polarization of the recoil protons at the second resonance is due to interference with the first resonance at 300 MeV of opposite parity. The present authors suggest an alternative explanation of the polarization in terms of interference between the second resonance and the third at 1100 MeV. The observed angular distribution and polarization can be fitted by a level scheme in which the first resonance has $T = \frac{3}{2}$, $J = \frac{3}{2}$, parity +; the second has $T = \frac{1}{2}$, $J = \frac{3}{2}$, parity +; and the third has $T = \frac{1}{2}$, $J = \frac{3}{2}$, parity −. The small $\cos^3\theta$ and $\cos^4\theta$ terms in the measured distributions could be explained by the presence of $J = \frac{5}{2}$ resonances at energies >1100 MeV. The suggested scheme, however, cannot explain the small positive coefficient of $\cos^2\theta$ in the photoproduction of π^+ near 500 MeV, but this experimental result could possibly be in error. R.E.Meads

539.12

1303 EXPERIMENTAL RESULTS ON PION PRODUCTION COMPARED WITH PREDICTIONS OF THE ISOBAR MODEL.
V.Alles-Borelli, S.Bergia, E.P.Ferreira and P.Waloschek.
Nuovo Cimento, Vol. 14, No. 1, 211-24 (Oct. 1, 1959).

The predictions of the model of Lindenbaum and Sternheimer are compared with results obtained from the analysis of the reactions $\pi^- + p \to \pi^- + \pi^+ + n$; $\pi^- + p \to \pi^- + \pi^0 + p$, observed in an H_2 bubble chamber. It was not possible to find any contradiction and all results concerning momentum spectra and branching ratios are sufficiently well described by the model. In the favourable case: $\pi^- + p \to \pi^+ + I^- \to \pi^+ + (\pi^- + n)$, the correct Q-value distribution for the isobar is obtained and angular correlation in its decay are compatible with a $J = \frac{3}{2}$ for the $(\pi^- + n)$-pair.

539.12

1304 THE NATURE OF THE NEUTRAL PARTICLES EMITTED IN $K_{\beta 3}$ DECAY. K.Imaeda and M.Shaukat.
Nuovo Cimento, Vol. 14, No. 3, 493-8 (Nov. 1, 1959).

An event was observed in photographic emulsion in which a K^+-meson appears to decay at rest to a positron and a Dalitz electron-pair. The results of dynamical analysis, coupled with considerations of conservation of spin are interpreted as providing direct evidence of π^0 in $K_{\beta 3}$ decay.

539.12

1305 PION—PION INTERACTION IN τ^+-MESON DECAY.
B.S.Thomas and W.G.Holladay.
Phys. Rev., Vol. 115, No. 5, 1329-30 (Sept. 1, 1959).

The deviations of the π^- spectrum in τ^+-meson decay from the Dalitz—Fabri distribution (Abstr. 6913, 7758 of 1954) in the 0^- state are analysed on the assumption of a π^+—π^+ short-range interaction. Agreement with experiment is found if the absolute value of the π^+—π^+ scattering length $|a|$ is 1.4×10^{-13} cm. The π^+ spectrum is also calculated on the basis of this scattering length and is found to agree with the experimental results.

539.12

1306 INTERFERENCE EFFECTS IN NEUTRAL K-PARTICLE DECAY. S.B.Treiman and S.Weinberg.
Phys. Rev., Vol. 116, No. 1, 239-40 (Oct. 1, 1959).

An analysis is made of interference effects between the K_1^0 and K_2^0 components of a neutral K beam for decay in the channel $\pi^+ + \pi^- + \pi^0$. The effects discussed, though expected to be small, may just be detectable. If so, they would serve as a test of the proposed $|\Delta T| = \frac{1}{2}$ rule.

539.12

1307 DETERMINATION OF THE PARITY OF THE K-MESON.
L.B.Okun' and I.Ya.Pomeranchuk.
Zh. eksper. teor. Fiz., Vol. 34, No. 4, 997-8 (April, 1958). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 34(7), No. 4, 688-9 (Oct., 1958).

The K—Λ relative parity could be determined from an observation of the energy and angular distributions of the product particles in the reactions

$$K^- + p \to \Lambda^0 + \pi^0 + \pi^0 \text{ and } K^- + p \to \Lambda^0 + \pi^+ + \pi^-,$$

provided the K^- capture in hydrogen is from S-states. J.C.Taylor

539.12

1308 THE INTERACTION OF K^--MESONS WITH PHOTOGRAPHIC EMULSION NUCLEI. II. THE EMISSION OF HYPERONS FROM K^--INTERACTIONS AT REST.
K^--collaboration (B.Bhowmik, D.Evans, D.Falla, F.Hassan, A.A.Kamal, K.K.Nagpaul, D.J.J. Prowse, M.René, G.Alexander, R.H.W.Johnston, C.O'Ceallaigh, D.Keefe, E.H.S.Burhop, D.H.Davis, R.C.Kumar, W.B.Lasich, M.A.Shaukat, F.R.Stannard, M.Bacchella, A.Bonetti, C.Dilworth, G.Occhialini, L.Scarsi, M.Grilli, L.Guerriero, L. von Lindern, M.Merlin and A.Salandin).
Nuovo Cimento, Vol. 14, No. 2, 315-64 (Oct. 16, 1959).

For Pt I see Abstr. 13575 (1959). The emission of Σ-hyperons from 3037 K^- capture stars at rest in nuclear emulsion was studied. The identification of the hyperons is discussed. Charged Σ-hyperons are emitted from (17.6 ± 1.0)% of all K^--stars while (9.6 ± 0.6)% of them lead to the emission of both Σ-hyperons and π-mesons. The Σ^-/Σ^+ ratio for all stars is 0.86 ± 0.12 while for stars in which a π-meson is also emitted it is 0.45 ± 0.10. The difference between this latter value and the markedly different value (2.0) obtained for K^--interactions at rest in a hydrogen bubble chamber is attributed to the Fermi motion of nucleons in the nucleus, and a dependence of the relative K^- transition amplitudes on the energy of relative motion of the K^--meson and nucleon. The branching ratio, R, of the number of Σ^+ decays to π^+ and proton respectively is 1.23 ± 0.27. The stable prong distribution of the stars in which a hyperon is emitted, as well as the energy distribution of the Σ-hyperons at emission has been studied. About 16% of all identified charged Σ-hyperons had an emission energy above 60 MeV, and had to be attributed to multi-nucleon interactions of the K^--meson. It is estimated that the proportion of all multi-nucleon primary capture processes may be as high as (30 – 40)%. The interaction of a K^--meson with a pair of neutrons seems to occur rarely, if at all. From the fraction of Σ^+ emitting stars which also emit a π^--meson it is concluded that only about 10% of the π^--mesons fail to escape from the nucleus in which capture occurs. This could be understood if K^--capture occurs predominantly in the peripheral region of the nucleus. From a similar study of Σ^- emitting stars it is found however that the proportion of π^+ or π^0-mesons, or both, that are absorbed in the nucleus is much higher. Estimates are made of the mean free path in nuclear matter of Σ-hyperons and π^0-mesons. Most of the one-nucleon interactions leading to Σ-hyperon production take place with protons and the transition amplitudes corresponding to the $T = 1$ state of isotopic spin is smaller than the $T = 0$ transition amplitude.

539.12

1309 K^+–DEUTERON SCATTERING IN THE IMPULSE APPROXIMATION. E.M.Ferreira.

Phys. Rev., Vol. 115, No. 6, 1727-9 (Sept. 15, 1959).

It is suggested that a phenomenological analysis using the impulse approximation of the processes occuring in the scattering of K^+ mesons by deuterons may be used to obtain the phase-shifts for the $T = 0$ isotopic spin state. Typical curves are given for the elastic, elastic plus inelastic and charge-exchange scattering differential cross-sections of 100 MeV K^+ mesons by deuterons on the assumption that only S-waves contribute and for various ratios of the $T = 1$ and $T = 0$ isotopic spin states phase shifts.

539.12

1310 TEST OF GLOBAL SYMMETRY IN K^-–p REACTIONS. M.H.Ross and G.L.Shaw.

Phys. Rev., Vol. 115, No. 6, 1773-7 (Sept. 15, 1959).

A method of testing the hypothesis that there is global symmetry of the pion–baryon interaction is proposed. Upon analysing low-energy K^-–p scattering data, one finds a variety of scattering length solutions which are compatible with the elastic scattering, charge-exchange scattering, and total charged hyperon production. The authors' suggestion involves the use of the experimental Σ^+/Σ^- ratios (a) to test the global symmetry hypothesis (or any other quantitative description of the pion–hyperon interaction), (b) to reduce the ambiguity in the $\bar{K}$–N scattering length solutions, (c) hence, to predict the Σ^0 cross-section. One needs to know the π–Y phase shifts, in addition to the $\bar{K}$–N scattering lengths, in order to predict the Σ^+, Σ^- cross-sections. If there is global symmetry of pion–baryon interactions, then the π–Y phases are known in the absence of a $\bar{K}$–N reaction channel. It is demonstrated how the actual π–Y phase shifts can be obtained, in a nonperturbative manner, from idealized π–Y phases (i.e., in the absence of $\bar{K}$–N reactions) and the $\bar{K}$–N scattering lengths. Earlier proposals making use of the dependence of the hyperon production ratios on the π–Y phase shifts are also examined in terms of this result. Certain fits to the present rough data with scattering lengths of negative real part are shown to be incompatible with global symmetry. The proposed analysis involves the assumption that the $\bar{K}$ is an isotopic doublet.

539.12

1311 K^-–NUCLEON SCATTERING LENGTHS AND THE K^-–d SCATTERING REACTIONS.

T.B.Day, G.A.Snow and J.Sucher.

Nuovo Cimento, Vol. 14, No. 3, 637-48 (Nov. 1, 1959).

The K^-–d elastic and total cross-sections are calculated, using a model which includes multiple scattering effects. The scattering lengths which Dalitz and Tuan find as fits to the K^-–p data are used in an attempt to distinguish between the four possibilities. The impulse approximation fails to give sensible results in this problem.

539.12

1312 ABSORPTIONS OF K^- MESONS AT REST IN LIGHT AND HEAVY NUCLEI OF THE EMULSION. C.Grote, I.Hauser, U.Kundt, U.Krecker, K.Lanius, K.Lewin and H.W.Meier.

Nuovo Cimento, Vol. 14, No. 3, 532-9 (Nov. 1, 1959).

1000 K^- captures at rest have been analysed in an emulsion stack exposed to the Berkeley Bevatron. In (38.4 ± 2)% of the events pions were emitted. The K^- captures have been separated into those in the light and those in the heavy nuclei of the emulsion. 25% of the events were captures in light nuclei.

Hyperons

539.12

1313 STRONG-COUPLING THEORY OF THE $S = -1$ HYPERONS: THE Λ^0 AS A BOUND STATE.

L.F.Landowitz and B.Margolis.

Phys. Rev. Letters, Vol. 2, No. 7, 318-19 (April 1, 1959).

The $S = -1$ hyperons are regarded as the stationary states of a system consisting of a $T = 1$ baryon core with linear charge-independent coupling to the pseudoscalar pion field. Treating this system in the strong-coupling approximation (Abstr. 1656 of 1959) and using the same coupling constant as in the nucleon case, the ground state is found to have $t = 0$, $j = \frac{1}{2}$ and the first two excited states, at 59 and 89 MeV respectively, have $t = 1$, $j = \frac{1}{2}$ and $t = 1$, $j = \frac{3}{2}$. Identifying the lowest two states as the Λ^0 and the Σ, — the experimental mass-difference is 75 MeV — this requires the Λ^0 and the Σ to have the same parity. The $j = \frac{3}{2}$ state should give rise to a resonance in K^--p scattering, albeit at negative kinetic energy.

P.K.Kabir

539.12

1314 THE INFLUENCE OF STRONG INTERACTION ON DECAY PROCESSES. N.Hu, N.N.Huang and P.Wang.

Scientia Sinica, Vol. 8, No. 11, 1343-52 (Nov., 1959).

It is shown that the strong interaction introduces not only phase shifts representing final-state interaction but also new parameters into the transition matrix for hyperon decay processes. These parameters must be determined by solving problems of physical hyperons under strong interaction with the π-meson and K-meson fields. As a consequence the selection rule read off from the Hamiltonian is in general different from that given by the transition matrix. The general consideration is also applied to the case of universal Fermi interactions including hyperons. Consistency with the selection rule $\Delta T = \pm 1/2$ cannot be achieved unless the interaction also includes the charge-retention pairs such as (N^+, N^+), (N^0, N^0) and (N^0, Λ^0). The theoretical difficulties of including these pairs are also discussed.

539.12

1315 ON THE PIONIC DECAY OF THE Λ-PARTICLE. L.Tenaglia.

Nuovo Cimento, Vol. 14, No. 3, 499-508 (Nov. 1, 1959).

On the hypothesis that the pionic decay of the Λ-particle is due to a Fermi interaction, the corrections to the axial and vector coupling constants are evaluated by the Goldberger and Treiman procedure. On account of the fact that only the intermediate nucleon–antinucleon states give appreciable contribution to the corrections, their evaluation depends on the complex phase-shifts of the nucleon–antinucleon scattering. Such phase-shifts are not known well enough to be able to derive from them reliable information on the pionic Λ-decay; therefore — aside from a qualitative discussion of the problem based on the complex phase-shifts of nucleon–antinucleon scattering — the author refers explicitly to the well known corrections to the axial coupling constant in the decay of the pion ($\pi \to \mu\nu$). This comparison allows one to apply quantitatively the procedure only to the decay $\Lambda \to p\pi^-$; the results are satisfactory. It is also possible to verify that the constants in the decay Hamiltonian of the Λ are strongly modified when one takes into account the possible corrections to the Fermi interactions amongst bare particles (virtual emission of pions by the Λ-particle, and reabsorption by the Λ or by the nucleon in the final state). Therefore, with the followed procedure, one has to assume that the Fermi interaction operates among dressed spinors.

539.12

1316 CHARGE INDEPENDENCE IN HYPERON PRODUCTION. F.S.Crawford, Jr, R.L.Douglass, M.L.Good, G.R.Kalbfleisch, M.L.Stevenson and H.K.Ticho.

Phys. Rev. Letters, Vol. 3, No. 8, 394-6 (Oct. 15, 1959).

New measurements of the absolute differential cross-section for the reactions

$$\begin{aligned}\pi^- + p \to\ & \Sigma^0 + K^0 \\ & \Sigma^- + K^+\end{aligned}$$

have been made using a hydrogen bubble chamber. The results show much higher cross-sections in the forward and backward directions respectively than previous propane chamber measurements of these reactions. This removes the apparent contradiction between experiment and the inequalities which charge independence requires between these cross-sections and those for

$$\pi^+ + p \rightarrow \Sigma^+ + K^+$$

R.F.Peierls

Strange particles

539.12

1317

EVIDENCE FOR THE ΔI = 1/2 RULE.

F.S.Crawford,Jr, M.Cresti, R.L.Douglass, M.L.Good, G.R.Kalbfleisch, M.L.Stevenson and H.K.Ticho.

Phys. Rev. Letters, Vol. 2, No. 6, 266-9 (March 15, 1959).

Discrepancies between the predictions of the ΔI = 1/2 rule and certain experimental results on strange particle decays are pointed out. Findings of the authors' investigations on neutral decays are presented. 1091 events corresponding to $\pi^- + p \rightarrow \Lambda, \Sigma^0 + K^0$ have been observed at pion momenta of 0.95, 1.03, 1.09, 1.12 and 1.23 GeV/c. Of the events 227 were double decays, 594 show only the Λ and 270 only the K^0 decay. From these figures and corrections for detection and scanning efficiency the authors find for the branching ratios

$$R_K = P(K_1^0 \rightarrow \pi^+ + \pi^-)/\text{ all } K^0 = 0.339 \pm 0.020$$

and

$$R_\Lambda = P(\Lambda \rightarrow \pi + p)/\text{ all } \Lambda \qquad = 0.627 \pm 0.031,$$

the values being averaged over the momenta used. Three decays $K^0 \rightarrow 2\pi^0$ were identified. From an estimate of the detection efficiency for these events the ratios

$$B = P(K_1^0 \rightarrow 2\pi^0)/\text{ all } K_1^0 = 0.27 \pm 0.11$$

and

$$f = K_1^0/\text{ all } K^0 \qquad = 0.47 \pm 0.080$$

are deduced. These values of the branching ratios are in good agreement with the predictions of the ΔI = 1/2 rule modified by the admixture of ΔI = 3/2 to account for the $K^+ \rightarrow 2\pi$ decay mode. The value of B disagrees with that obtained by other investigators. Three neutral decays $\Lambda \rightarrow n + \pi^0$ were identified yielding a further value for R_Λ. The weighted mean value R = 0.624 ± 0.030 agrees with theory. Evidence on Ξ, Σ^0 and K decays obtained in other experiments is summarized and found to support the ΔI = 1/2 rule.

E.G.Michaelis

539.12

1318

USEFUL SYMMETRIES OF STRONG INTERACTIONS.

J.J.Sakurai.

Phys. Rev., Vol. 115, No. 5, 1304-9 (Sept. 1, 1959).

An attempt is made to deduce "useful" relations among strange particle reactions slightly stronger than those implied by charge independence in the conventional sense. As Pais has shown (Abstr. 3704, 6626 of 1958) there are no such relations that hold to all orders aside from those already contradicted by experiments. However, for the relative ΛΣ parity even and $G_{K\Lambda N} = (\pm)G_{K\Sigma N}$, $G_{K\Xi\Lambda} = (\pm)G_{K\ \ \Sigma}$, there exist relations that are valid as long as virtual pions play no role (as is evident from a recent unpublished work of Feynman). In particular, if one has, in addition $G_{\pi\Lambda\Sigma} = (\mp)G_{\pi\Sigma\Sigma}$ (which means that the π couplings and the K couplings exhibit opposite four-dimensional symmetries), the weaker condition that pions emitted by N and Ξ (Λ and Σ) be not absorbed by Λ and Σ (N and Ξ) is sufficient for the validity of such relations. Empirical examples are given. The question of the baryon mass spectrum is discussed.

539.12

1319

STRANGE PARTICLE PRODUCTION BY BEVATRON NEUTRONS IN PROPANE.

C.O.Dechand.

Phys. Rev., Vol. 115, No. 6, 1730-4 (Sept. 15, 1959).

A liquid propane bubble chamber was exposed to a beam of neutrons with energies up to 6 BeV from a bevatron. 10 000 pictures of interactions in the hydrocarbon were scanned to detect neutral heavy unstable particles. 349 neutral V-events were found, most of which came from the stainless steel walls of the chamber. 86% of these events could be identified as one or the other or either of the neutral strange particles: Λ^0 or $\theta_1{}^0$. The $\Lambda^0/\theta_1{}^0$ ratio is about 0.6- 8200 stars of 2 or more prongs formed by neutrons interacting in the liquid propane were observed in the chamber and 17 of these produced V^0's. An additional 5 V^0's were formed in single-prong events produced by neutrons, and 8 others were produced in events in the propane caused by charged particles. The energy spectrum of the incident neutrons was estimated from study of π-meson production interactions in the hydrogen. The distribution shows that the neutrons had energies up to 6 BeV with a mean value of about 4 BeV. For the energy range 1 to 6 BeV, the production of strange particles occurs in about 1% of all inelastic interactions of neutrons with hydrogen and carbon.

Deuterons

539.12

1320

ELASTIC SCATTERING OF HIGH-ENERGY PARTICLES BY DEUTERONS.

A.A.Rukhadze.

Zh. eksper. teor. Fiz. Vol.34, No.4, 1014-15, (April, 1958). In Russian. English translation in: Soviet Physics-JETP (New York), Vol.34(7), No.4, 700-1 (Oct., 1958).

Elastic scattering of 675 MeV protons by deuterons gives information about the deuteron wave-function for small r. The cross-section is the product of the total cross-section for quasi-elastic scattering times the probability that the proton and neutron are found within a distance λ (the incoming particle wavelength). An estimate based on small λ and a ^{3}S deuteron wave-function agrees qualitatively with experiment.

D.W.L.Sprung

539.12

1321

METHOD FOR PRODUCING ALIGNED DEUTERONS.

M.E.Rose.

Phys. Rev. Letters, Vol. 3, No. 8, 387 (Oct. 15, 1959).

Almost complete alignment of the spins of a beam of deuterons along the direction of motion is obtained when thermal neutrons are captured in hydrogen since the capture occurs largely through the virtual $^1S_0$ state and the 2.23 MeV photon carries off an angular momentum component ±1 with respect to its own propagation direction. The transition from the J = 0 state to the J = 1 deuteron ground state would populate only the M = ±1 substates. The low energy (1.3 keV) deuterons could possibly accelerated without dealignment, and the alignment detected by angular distribution measurements of the $T(d,n)He^4$ reaction. The degree of alignment produced in any recoil nucleus by a γ transition from J to J' is discussed and also the effect of taking into account n—p capture via the ^{3}S state on the above result. The effect of finite angle of acceptance of the recoils is taken into account.

R.E.Meads

Alpha-particles

539.12

1322

THE EXPERIMENTAL DETERMINATION OF THE RANGE-ENERGY RELATIONS FOR ALPHA PARTICLES IN WATER AND WATER VAPOUR, AND THE STOPPING POWER OF WATER AND WATER VAPOUR FOR ALPHA PARTICLES AT ENERGIES BELOW 8.78 MeV.

R.B.J.Palmer and H.A.B.Simons.

Proc. Phys. Soc., Vol. 74, Pt 5, 585-98 (Nov., 1959).

A method for measuring the residual energy of alpha particles which have traversed paths of various lengths in water is described, and also a method for determining total alpha-particle range in water, the results being used to deduce a range—energy relation for alpha particles of energy up to 8.78 MeV in liquid water. A method is described for measuring the residual energy of alpha particles which have passed through air and through water vapour, and by means of a scintillation detector the complete alpha-particle range in air and in water vapour is established. From these results range—energy relations are deduced for alpha particles in air and in water vapour. The differential and integral stopping power of water and water vapour at various energies is calculated and the results are discussed.

COSMIC RAYS

(Nuclear reactions due to cosmic rays are included under Nuclear Reactions)

537.59

1323

SATELLITE OBSERVATIONS OF SOLAR COSMIC RAYS.

P.Rothwell and C.McIlwain.

Nature (London), Vol. 184, 138-40 (July 18, 1959).

Shielded and unshielded counters, sensitive to protons of energy greater than 40 MeV and 30 MeV and electrons of 5 MeV and 3 MeV, respectively, were exposed to cosmic rays in the Explorer IV (1958ε) satellite. On three occasions in August 1958 increases in the cosmic ray primary intensity of one or more orders of magnitude were observed. The possibility of these being due to passages through the Van Allen belt is excluded by the low value of the unshielded/shielded ratio, which is typically 2 or 3 compared with 30 or 40 for Van Allen radiation. It is suggested that the increases were due to emission of protons of the order of 100 MeV by the sun in connection with the solar flares of August 16, 22 and 26. This is supported by other high-altitude experiments. It is further suggested that the anomalous cosmic ray increases rarely observed at sea level are unusually energetic examples of this phenomenon.

R.H.W.Johnston

537.59 : 523.85

1324 COSMIC RAY EXCHANGES BETWEEN GALACTIC HALO AND CENTRE. M.Johnson.

Observatory, Vol. 79, 109-11 (June, 1959).

Fast particles may be guided by magnetic fields from the central nucleus along the spiral arms and into the halo where they may be further accelerated. The possibility of motion in the opposite sense is also mentioned.

G.A.Chisnall

537.59

1325 THE SUN AS A SOURCE OF COSMIC RAYS OF INTERMEDIATE ENERGIES. J.Katzman.

Canad. J. Phys., Vol. 37, No. 11, 1207-15 (Nov., 1959).

The cosmic ray intensity as measured with an extremely narrow-angle telescope, 1.2×10^{-3} sterad, and with 96 in. of lead as absorber for the period 1 January 1955 to 31 December 1958 shows an increase of 20%. This increase is attributed to particles coming from the sun. It is shown that the change in hour of maximum of the first and second harmonics can be explained by a change in the relative importance of the impact zones. This phenomenon is attributed to a change in the number and polarity of sunspots.

537.59

1326 COSMIC-RAY NEUTRON ENERGY SPECTRUM. W.N.Hess, H.W.Patterson, R.Wallace and E.L.Chupp.

Phys. Rev., Vol. 116, No. 2, 445-57 (Oct. 15, 1959).

The cosmic-ray neutron energy spectrum in the equilibrium region of the atmosphere was measured with several different calibrated detectors from thermal energies to about 1 BeV at 44^0 north magnetic latitude and up to 40 000 ft. By combination of the data from these measurements with those from other experiments, a complete differential energy spectrum is obtained which shows the characteristic maximum near thermal energies and a roughly 1/E variation up to about 100 keV. The presence of a second maximum in the spectrum near 1 MeV is attributed to the evaporation neutrons from stars, and above this energy up to 800 MeV the spectrum falls off as $E^{-1.4}$.

537.59 : 539.12

1327 POLARIZATION OF MU-MESON IN COSMIC RAYS. I.I.Gol'dman.

Zh. eksper. teor. Fiz., Vol. 34, No. 4, 1017-19 (April, 1958). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 34(7), No. 4, 702-4 (Oct., 1958).

Predicts theoretically that the polarization of mu-mesons arising from the decay of K-mesons should be practically complete, whilst for those arising from pi-meson decay only 30% will be polarized. Therefore measurements of the degree of polarization of mu-mesons in cosmic rays would make it possible to determine the ratio of K- and pi-mesons produced in the upper atmosphere.

J.W.Sturgess

537.59

1328 INFLUENCE OF MULTIPLE SCATTERING ON THE DEVELOPMENT OF HIGH-ENERGY ELECTRON–PHOTON CASCADES IN LEAD.

T.G.Volkonskaya, I.P.Ivanenko and G.A.Timofeev.

Zh. eksper. teor. Fiz., Vol. 35, No. 1(7), 283-4 (July, 1958). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 35(8), No. 1, 202-3 (Jan., 1959).

Monte-Carlo type calculations have been used to calculate the longitudinal development of cascade showers initiated by 10^{12} eV electrons and photons in lead, taking into account the effect of multiple scattering on the cross-sections for bremsstrahlung and pair production. A small shift of the spectrum towards the high energy end was found. It is concluded that great statistical accuracy would be required to confirm the results experimentally.

J.D.Dowell

537.59

1329 THE ROLE OF ANTINUCLEONS AND MESONS IN SECONDARY INTERACTIONS IN THE HIGH ENERGY REGION. Zh.Takibaev.

Dokl. Akad. Nauk SSSR, Vol. 127, No. 1, 67-9 (July 1, 1959). In Russian.

Recent observations on the angular distribution of charged particles in showers do not agree with two centre of emission models. These are now explained by a two-stage model in which antinucleons and mesons formed in the first stage of collision undergo further interactions.

D.W.L.Sprung

537.59

1330 MEASUREMENT OF PRIMARY DIRECTIONS IN EXTENSIVE AIR SHOWERS. C.B.A.McCusker.

Phys. Rev., Vol. 116, No. 1, 177-80 (Oct. 1, 1959).

The abilities of various extensive shower arrays to detect possible departures from isotropy of the directions of incidence of very high-energy cosmic-ray primaries are analysed. The effects of angular resolution, selectivity of total energy and sensitivity to the nature of the primary are discussed. A simple method of analysing variation in intensity with declination is given and applied to some recent experimental results. It is shown that in two well-known cases these are not consistent with the hypothesis of isotropy of incoming directions.

537.59

1331 DIRECTIONAL PROPERTIES OF AN EXTENSIVE AIR SHOWER ARRAY.

C.B.A.McCusker, D.E.Page, and R.J.Reid.

Phys. Rev., Vol. 116, No. 1, 181-2 (Oct. 1, 1959).

The directional properties of an extensive-air-shower array consisting of three Geiger—Müller counter telescopes were examined. It is shown that the directional properties of this array show no great improvement over more conventional arrangements. Possible ways of improving the performance of the device are suggested.

537.59

1332 ON THE STRUCTURE OF EXTENSIVE COSMIC RAY AIR SHOWERS: THE PENETRATING COMPONENT.

E.W.Kellermann and N.Dickinson.

Proc. Phys. Soc., Vol. 74, Pt 5, 554-60 (Nov., 1959).

The penetrating components of extensive cosmic-ray air showers of sizes ranging from 4×10^4 to 5×10^5 particles were examined at distances from 3 to 18 metres from the shower cores. Within these distances the nucleonic particles, of energy 2 GeV or larger, examined here have a lateral distribution not flatter than that of the electrons which is described by a power law $r^{-0.75}$, whereas the muon component decreases as $r^{-0.3}$ with distance from the core. The numbers of nucleonic particles and muons decrease relative to the electron numbers N with increasing shower size, the number of nucleons being proportional to $N^{0.6}$.

537.59

1333 PRIMARY COSMIC-RAY PROTON AND ALPHA-PARTICLE INTENSITIES AND THEIR VARIATION WITH TIME. P.Meyer.

Phys. Rev., Vol. 115, No. 6, 1734-41 (Sept. 15, 1959).

A series of high-altitude balloon flights was carried out in 1957 and 1958 to study the flux of primary cosmic-ray protons and α-particles during variations in the total cosmic-ray intensity. The following results are obtained for α-particles with energies exceeding 530 MeV/nucleon under 13.5 g/cm^2 of air: (a) during a large Forbush-type decrease the α-particle and proton intensities were closely correlated, this demonstrates that a modulation mechanism is operating on both components; (b) at certain times variations in the α-particle intensity were observed within a few hours which were not accompanied by corresponding changes in the proton flux, this is tentatively ascribed to an anisotropy in the α-particle flux that reaches the earth; (c) while there existed an intensity decrease in the proton flux between 1957 and 1958 which is also observed in the neutron monitor station data, no such variation occurred in the α-particle flux. A division of the α-particles into two energy groups (450 MeV/nucleon $\leq E_1 \leq$ 960 MeV/nucleon and $E_2 \geq$ 960 MeV/nucleon) shows (a) that the Forbush decrease is of the same magnitude in both energy groups, (b) that the hourly flux increase observed in some flights is about the same in both energy groups, and (c) that from 1957 to 1958 the flux in the low-energy group increased, while it decreased in the high-energy interval, contrary to the well-known behaviour of the proton flux. These independent α-particle flux variations cannot be explained by any of the modulation mechanisms so far proposed. It is suggested that occasional solar production of α-particles may be responsible for these results. The absolute flux of α-particles with energies exceeding 500 MeV/nucleon at the top of the atmosphere was measured on five different days.

537.59

1334 SUDDEN INCREASE OF COSMIC-RAY INTENSITY. H.R.Anderson.

Phys. Rev., Vol. 116, No. 2, 461-2 (Oct. 15, 1959).

A sudden 30% increase in cosmic-ray intensity lasting approximately 12 minutes was observed at an atmospheric depth equal to 80 g/cm^2 by a Neher integrating ionization chamber flown from Bismarck, North Dakota on October 16, 1958. A similar measurement made simultaneously at Invercargill, New Zealand observed no increase. These observations are not in accord with the simple solar impact zone theory.

537.59

1335 PRIMARY COSMIC-RAY INTENSITY NEAR SOLAR MAXIMUM. F.B.McDonald.

Phys. Rev., Vol. 116, No. 2, 462-3 (Oct. 15, 1959).

Measurements of the primary cosmic-ray proton and alpha-particle fluxes and energy spectra were extended to the recent period of solar maximum. While the rigidity dependence of both components changed greatly during the solar cycle, it is observed that alpha particles and protons maintain the same relative rigidity spectra during the solar cycle. Measured geomagnetic cutoff values are in agreement with those obtained at solar minimum. An electric field model gives excellent agreement for the general form of the long-term change. However, at low rigidities this model predicts a splitting of the proton and alpha-particle differential rigidity spectra which is not observed.

537.59

1336 PRIMARY HEAVY COSMIC RAYS NEAR THE GEOMAGNETIC EQUATOR. O.B.Young and F.W.Zurheide.

Nuovo Cimento, Vol. 14, No. 1, 90-8 (Oct. 1, 1959).

G-5 emulsions were exposed in February, 1957 during the Operation Equex on two flights of about 100 000 ft altitudes for about $7\frac{1}{2}$ hr each. Tracks of nuclei of $Z \geq 10$ were studied. The δ-ray method of counting was used. Results are given for the angular distribution, charge spectrum, flux at the top of the atmosphere, and attenuation mean free path.

537.59

1337 HEAVY PRIMARY COSMIC RAYS AT GEOMAGNETIC LATITUDE OF 41°N. O.B.Young and H.Y.Chen.

Phys. Rev., Vol. 115, No. 6, 1719-21 (Sept. 15, 1959).

For previous work, see Abstr. 8083 (1958). Gives results from 9 balloon flights at geomagnetic latitude 41°N of altitude range from 70 000 to 100 000 ft. Only primaries of $Z \geq 10$ are considered. 2410 tracks are involved, in Ilford G-5 and G-0 emulsion exposures. The charge spectra, flux, mean free paths, and angular distributions are given.

537.59

1338 HEAVY NUCLEI IN THE PRIMARY COSMIC RADIATION AT PRINCE ALBERT, CANADA. I. CARBON, NITROGEN AND OXYGEN.

H.Aizu, Y.Fujimoto, S.Hasegawa, M.Koshiba, I.Mito, J.Nishimura, K.Yokoi and M.Schein.

Phys. Rev., Vol. 116, No. 2, 436-44 (Oct. 15, 1959).

A stack of G-5 emulsion, exposed at 120 000 ft for 8 hr at 61°N, was used to study the charge and energy spectrum of heavy nuclei at the low-energy end. Energy measurements were made on C, N and O nuclei up to 1 BeV/nucleon. The spectrum shows a broad maximum at 550 MeV/nucleon, extrapolated to the top of the atmosphere. Various possibilities to explain this spectrum are discussed.

537.59

1339 OBSERVATIONS OF SOLAR FLARE RADIATION AT HIGH LATITUDE DURING THE PERIOD JULY 10-17, 1959. R.R.Brown and R.G.D'Arcy.

Phys. Rev. Letters, Vol. 3, No. 8, 390-2 (Oct. 15, 1959).

An array of counters, carried by balloon to ~ 20 g/cm^2 atmospheric depth, was used to observe cosmic ray intensity increases associated with solar flares on July 10, 14 and 16, 1959. Preliminary analysis of the telemetered data indicates that the flare radiation, assumed to be protons, was an energy spectrum of the form $N(E)\,dE = kE^{-4.5}\,dE$ for $100 < E < 400$ MeV, and that energies up to 500 MeV occur. γ-rays of 3-5 MeV were also detected.

R.F.W.Johnston

537.59

1340 UNUSUAL COSMIC-RAY FLUCTUATIONS ON JULY 17 AND 18, 1959. H.Carmichael and J.F.Steltes.

Phys. Rev. Letters, Vol. 3, No. 8, 392-4 (Oct. 15, 1959).

A decrease in the sea-level neutron intensity, apparently different in behaviour from the type of decrease observed on five previous occasions in association with solar flares, was observed on July 17th 1959. A correlated decrease was observed in the counting-rate of a lead-shielded ion-chamber, suggesting that the event was associated with high-energy cosmic ray primaries and may have been of galactic origin.

R.H.W.Johnston

537.591

1341 INTENSITY VARIATIONS OF THE COSMIC RAY NUCLEONIC COMPONENT. M.A.Collins.

New Zealand J. Sci., Vol. 2, No. 3, 313-19 (Sept., 1959).

Measurements are presented of the nucleonic component of cosmic rays observed at Wellington, New Zealand. A 27-day recurrence is demonstrated but the increased counts show no tendency to be confined to the impact zone times of 04, 09 and 20 hours calculated by Lüst (Abstr. 4517 of 1957). Consequently it seems unlikely that the increases are due to particles coming directly from the sun. The suggestion of Parker (Abstr. 519 of 1957) that ionic clouds from the sun deflect particle streams originating elsewhere seems preferable.

537.59

1342 NUCLEAR INTERACTIONS AT ENERGIES OVER 1000 BeV. J.G.McEwen.

Phys. Rev., Vol. 115, No. 6, 1712-19 (Sept. 15, 1959).

Measurements on two jets, a $0 + 36p$ jet with primary energy about 2500 BeV and a $4 + 29\alpha$ jet with primary energy about 8000 BeV/nucleon, are presented. It is shown that the main features of the angular distribution of particles from these two primary jets and a third energetic secondary jet can be explained satisfactorily by the model in which mesons created in a nucleon—nucleon collision are considered to be radiated isotropically from two centres. Further implications of this model are discussed; in particular it is shown that definite restrictions are imposed on the values of energy and angle of emission of secondary particles; the average transverse momentum is predicted to be relatively constant but to have a lower value not only in the forward and backward directions but also around 90° in the centre-of-mass system of the two colliding nucleons. While it is shown that the available experimental data are in accord with these predictions, more events with energies in the region of 1000 BeV must be studied before a definite conclusion can be reached.

537.59

1343 THE INFLUENCE OF CARBON ABSORBERS ON NEUTRON PRODUCTION IN LEAD BY COSMIC RADIATION AND THE ABSOLUTE FREQUENCY OF NUCLEAR CASCADES IN VARIOUS THICKNESSES OF LEAD. P.K.Sen Chaudhury and G.Pfotzer.

Z. Naturforsch., Vol. 14a, No. 1, 10-23 (Jan., 1959). In German.

The rates of neutrons and neutron coincidences from a lead sheet under graphite absorbers, were measured for different thicknesses of graphite. Maxima are observed, but they can be explained by back scattering of the neutrons in the lead. To examine the nuclear processes in the lead, neutrons and neutron coincidences were counted for lead sheets of various thicknesses and at different distances from the counters. The results showed that the frequency of nuclear cascades in various thicknesses of lead is related to the transition effect (detected as a maximum of the "star" frequency in nuclear plates, by Rössele and Schaffer). The value obtained for the absolute intensity of the nuclear active component of cosmic rays agrees with those of other authors.

D.H.Lord

NUCLEUS

539.14

1344 PLAUSIBILITY OF A NONLOCAL OPTICAL MODEL. Y.C.Tang, R.H.Lemmer, P.J.Wyatt and A.E.S.Green.

Phys. Rev., Vol. 116, No. 2, 402-6 (Oct. 15, 1959).

The implication of a simple two-kernel form of nonlocal potential is considered in the nuclear matter approximation. It is shown that this leads to a wave equation with a complex reduced mass. The parameters characterizing the real part of the optical potential are found to be in reasonable accord with expectations from two-body forces. The parameters associated with the imaginary part are handled only phenomenologically. A description is found which works quite well in the energy range 0 to 25 MeV. The results of this study compares favourably with the corresponding results of an investigation with a nonlocal model for finite nuclei.

539.14

1345 MODIFIED HARTREE—FOCK METHOD FOR THE FINITE NUCLEUS. K.A.Brueckner and D.T.Goldman.
Phys. Rev. Vol. 116, No. 2, 424-5 (Oct. 15, 1959).

A procedure is given for including the rearrangement energy term in the Brueckner—Gammel method (Abstr. 4261 of 1958) for evaluating the structure of finite nuclei. A variational technique is used to derive the single-particle energy from the total binding energy of the nucleus. It is seen that although a rearrangement energy term does not appear explicitly in the total number binding energy and influence the eigenfunctions of the total nuclear system, and thus its energy eigenvalues. The rearrangement energy has a noticeable effect on the single-particle wave equation and must be included in finite nucleus calculations. To a good approximation, it is shown that it is possible to evaluate the rearrangement potential and to express it as a simple function of the mean nuclear density, i.e., $V_r = (240\ \text{MeV})\rho^2 \times (10^{-13}\ \text{cm})^6$.

539.14

1346 PHENOMENOLOGICAL NUCLEAR INTERACTION DERIVED FROM BINDING ENERGIES. R.Thieberger.
Phys. Rev., Vol. 116, No. 3, 713-19 (Nov. 1, 1959).

An attempt is made to clarify the basis of a formula for binding energies derived in the framework of the j-j coupling shell model. Studies are made of the effect of three-body correlations, by introducing a density dependent term. It is seen that the j-j coupling calculation can be suitably corrected for the many-body effects. The hard-core influence is introduced as a pseudopotential. An attempt is made to fit the binding energies with a phenomenological central potential, including a density-dependent term. The best exchange mixture obtained is not far from a Serber type but includes a considerable amount of Bartlett force. When the hard core is included, the best exchange mixture becomes of the Serber-type. With this potential a good fit is obtained over a large range of configurations.

539.14

1347 NEW MODEL FOR VIBRATIONAL SPECTRA IN EVEN—EVEN NUCLEI. T.Tamura and L.G.Komai.
Phys. Rev. Letters, Vol. 3, No. 7, 344-6 (Oct. 1, 1959).

It is shown that the vibrating surface model can be brought into agreement with experiment if the dependence of the energy on deformation has a suitable form. D.J.Thouless

539.14

1348 SUPERFLUIDITY OF NUCLEAR MATTER. R.L.Mills, A.M.Sessler, S.A.Moszkowski and D.G.Shankland.
Phys. Rev. Letters, Vol. 3, No. 8, 381-3 (Oct. 15, 1959).

By use of the variational principle, a careful study is made of whether the criterion for the existence of a superfluid state of infinite nuclear matter is satisfied. With the empirically determined nucleon—nucleon interaction, optical model potential, and nuclear density for heavy nuclei,it is found that the criterion is satisfied. At a slightly higher nuclear density, it appears that superfluidity would not occur. D.J.Thouless

539.14

1349 FOUNDATIONS OF THE OPTICAL MODEL FOR NUCLEI AND DIRECT INTERACTION. G.E.Brown.
Rev. mod. Phys., Vol. 31, No. 4, 893-919 (Oct., 1959).

This article reviews the work of Bloch, deDominicis, the author, and others, concerned with relating the optical model and direct interaction to many level nuclear dispersion theory. The Kapur—Peierls formalism is employed for the latter. It is shown that the optical model and direct interaction are contained in the many level treatment, provided that phase relations between different levels are treated properly. Statistical processes are also contained in the description, but it is plausible that random phase approximations can be made in describing them.

539.14

1350 THE DEFORMATION OF LIGHT NUCLEI. Yü Min, Teng Chia-hsien, Chou Hsiao-tsien and Lee Yang-kou.
Scientia Sinica, Vol. 8, No. 9, 935-61 (Sept., 1959).

A study of the relations between the ground state, excited states and the deformation of a number of nuclei is made on the basis of the collective model theory. Taking into consideration the pairing energy due to residual forces and the rotational perturbation, it is found that the effect of pairing energy on the nuclear deformation is small, while the effect of rotational perturbation is very great. In certain cases, such as O^{17} and O^{18}, the latter is great enough to change the shape of a nucleus from a prolate spheroid to a sphere and alter the order of levels corresponding to definite configurations.

539.14

1351 THE BINDING ENERGIES OF ATOMIC NUCLEI. I. INTRODUCTION AND GENERAL METHOD.
R.J.Eden and V.J.Emery.
Proc. Roy. Soc. A, Vol. 248, 266-81 (Nov. 11, 1958).

The energy of an atomic nucleus can be written as an expansion in terms of an effective two-nucleon interaction and a trial single-particle potential. The effective interaction can be derived from a phenomenological internucleon potential using a suitable extension of the methods of Brueckner for infinite nuclear matter. Coupled integro-differential equations are obtained for the relative wave-functions of pairs of nucleons. These are simplified by using a harmonic oscillator potential to give the one-particle wave-functions and by approximating the effects of the exclusion principle. A further modification of the method leads to a generalized perturbation procedure in which the more complicated parts of the inter-nucleon potential occur only in differential equations. A preliminary study is made of various methods for determining the matrix elements of the effective interaction and the relative wave-functions.

539.14

1352 HYPERFINE STRUCTURE AND NUCLEAR MOMENTS OF BROMINE-82.
H.L.Garvin, T.M.Green, E.Lipworth and W.A.Nierenberg.
Phys. Rev., Vol. 116, No. 2, 393-401 (Oct. 15, 1959).

The nuclear spin, the magnetic dipole, and the electric quadrupole interaction constants were measured for 35 hr Br^{82} by the method of atomic beams. The results are $I = 5$, $|a| = 205.04 \pm 0.05$ Mc/s, $|b| = 870.7 \pm 0.9$ Mc/s, and $b/a = -4.246 \pm 0.001$. The nuclear magnetic and electric quadrupole moments obtained from these values of a and b are $|\mu| = 1.6264 \pm 0.0005$ n.m. and $|Q| = 0.76 \pm 0.03$ barn. While only the relative sign μ and Q is determined, both μ and Q are almost certainly positive. A new method for solving the interaction Hamiltonian with magnetic field, for arbitrary I and J, by using an IBM 650 computer, is described.

539.14

1353 NUCLEAR SPIN, HYPERFINE-STRUCTURE SEPARATION, AND MAGNETIC MOMENT OF 22-HOUR POTASSIUM-43. F.R.Petersen, V.J.Ehlers, W.B.Ewbank, L.L.Marino and H.A.Shugart.
Phys. Rev., Vol. 116, No. 3, 734-7 (Nov. 1, 1959).

The nuclear spin and hyperfine-structure separation were measured by the atomic-beam magnetic-resonance method. The results are $I = \frac{3}{2}$, $\Delta\nu(^2S_{\frac{1}{2}}) = 192.64 \pm 0.05$ Mc/s. The nuclear magnetic moment calculated from these measurements is $|\mu| = 0.163 \pm 0.002$ nuclear magneton.

539.14

1354 MOMENTS OF INERTIA OF EVEN—EVEN RARE EARTHS. J.J.Griffin and M.Rich.
Phys. Rev. Letters, Vol. 3, No. 7, 342-3 (Oct. 1, 1959).

The formula for the effect of pairing interactions on the nuclear moment of inertia, which was derived by Belyaev in analogy with superconductivity theory, is used to calculate the moments of inertia of a series of even—even nuclei. The empirical quantities used in the calculation are given, and the results compared with the experimental energy of the first excited state. The agreement is good. D.J.Thouless

539.14

1355 ON THE UNORDERED FREE PRECESSION OF THE MAGNETIC MOMENTS OF ATOMIC NUCLEI.
G.V.Skrotskii and A.A.Kokin.
Zh. eksper. teor. Fiz., Vol. 36, No. 3, 932-3 (March, 1959).
In Russian.

It is shown that by using the conventional set-up for the measurement of the nuclear magnetic moment, under favourable circumstances it may be possible to separate from the spectrum of the thermal noise the signal of the unordered free precession of the magnetic moment. [English summary: PB 141052T-11, obtainable from Office of Technical Services, U.S. Dept. of Commerce, Washington, D.C., U.S.A.]. P.Roman

539.14

1356 NUCLEAR MOMENTS OF Os^{187}.

G.Guthöhrlein, H.Kopfermann, G.Nöldeke and A.Steudel.
Naturwissenschaften, Vol. 46, No. 21, 598-9 (1959). In German.

Investigated by means of the hyperfine structure of the 4974 and 4261 A lines. Each line split into two components, suggesting that $I(Os^{187}) = 1/2$. From the size and separation of the two components of each line, the magnetic dipole moment was determined as $\mu_I(Os^{187}) = +(0.065 \pm 0.003)$ nuclear magnetons. J.A.Evans

539.14

1357 MEASUREMENT OF THE NUCLEAR g FACTOR OF Li^8.

D.Connor.
Phys. Rev. Letters, Vol. 3, No. 9, 429-31 (Nov. 1, 1959).

The nuclear g factor of Li^8 was measured by first of all producing it in an aligned condition by irradiating a single crystal of Li^7F with polarized slow neutrons produced by reflection from a magnetized cobalt alloy mirror, and detecting the alignment by plastic phosphors arranged to measure the asymmetry of the β emission from Li^8 parallel and antiparallel to the expected alignment direction. The asymmetry observed was ~ 10%. A measured constant magnetic field was applied to the crystal along the direction of alignment and a variable frequency r.f. field at right angles to this direction. When the frequency of the r.f. corresponded to the nuclear Larmor frequency, depolarization of the Li^8 nuclei was observed. The polarization was completely removed by r.f. fields > 0.4 Oe. For a constant field of 5418 ± 1 Oe, the Larmor frequency $f_L = 3.413 \pm 0.001$ Mc/s. The g factor for Li^8 is therefore 0.8265 ± 0.0004 nm/h omitting diamagnetic corrections, and is close to the value obtained for Li^6. The corresponding magnetic moments of Li^8 (spin 2) is 1.653 ± 0.0008 nm. The calculated g factor for extreme j-j coupling, assuming both the odd neutron and proton to be in $p_{3/2}$ states is 0.63 or 0.69; for LS coupling it is 0.49. The measured result can be fitted by an intermediate coupling assumption.
R.E.Meads

539.14

1358 MAGNETIC MOMENT CALCULATION FOR Li^8.

D.Kurath.
Phys. Rev. Letters, Vol. 3, No. 9, 431 (Nov. 1, 1959).

The value of the nuclear magnetic moment of Li^8 was calculated using the intermediate coupling model, as a function of the spin—orbit parameter α/K, for the relative range of nuclear forces given by $L/K = 6.8$, assuming that the ground state is $J = 2$, $T = 1$. The measured value of 1.653 nm is fitted by the value $\alpha/K \cong 2.1$. This result is consistent with the fact that the M1 transition width for the γ decay of the 17.6 MeV level in Be^8 gives $\alpha/K \cong 2.5$.
R.E.Meads

539.14

1359 MIRROR NUCLEI RADII UTILIZING SELF-ENERGY TERM AND NONUNIFORM CHARGE DISTRIBUTIONS.

R.D.Cherry.
Phys. Rev., Vol. 115, No. 5, 1243-6 (Sept. 1, 1959).

The nature of the self-energy term in the mirror nucleus energy-difference formula is investigated. Two approaches are used. In the first this self-energy term is assumed to be a constant equal to the Coulomb self-energy of a single proton, and in the second a more refined quantum mechanical approach based on the Swamy and Green Coulomb exchange energy calculations is used. Both approaches yield r_0 values which possess the correct general trend with increasing A, but which disagree with theoretical values for very low A. The effect of nonuniform charge distributions on the values of nuclear radii obtained from mirror nuclei is investigated, and expressions for the Coulomb energy for various charge distributions are given. A direct comparison between the mirror nucleus radii and those obtained from electron scattering is made in the few cases where this is possible. Finally, the possible validity of a suggested value of 0.58 MeV for the Coulomb self-energy of the proton is discussed briefly.

539.14 : 539.17

1360 EVIDENCE FOR THE POLARIZATION OF B^{12} NUCLEI PRODUCED IN A (d,p) REACTION.

L F.Chase, Jr and G.Igo.
Phys. Rev., Vol. 116, No. 1, 170-2 (Oct. 1, 1959).

Evidence is presented that a lower limit for the polarization of B^{12} nuclei produced in the (d,p) reaction at 2.8 MeV is 17 ± 5%. The sign of the polarization P_R is in disagreement with the Newns model (Abstr. 7128 of 1953), and it is in agreement with a modified classical model. The sign of the proton polarization determined by Hillman (Abstr. 1602 of 1957) and by Juveland and Jentschke (Abstr. 9052 of 1958) is also in agreement with the modified classical model.

539.14

1361 ZERO-SPIN EXCITED STATE IN Ca^{42}.

I.Asplund and T.Wiedling.
Phys. Rev., Vol. 116, No. 3, 741-3 (Nov. 1, 1959).

An angular correlation measurement was carried out on the 0.3-1.5 MeV gamma cascade in Ca^{42}. It is shown that the observed angular correlation function

$$W(\theta) = 1 + 0.33\,P_2(\cos\theta) + 1.07\,P_4(\cos\theta)$$

fits the spin sequence 0-2-0.

539.14

1362 ENERGY LEVELS IN A BOUNDED ISOTROPIC HARMONIC OSCILLATOR POTENTIAL AND NUCLEAR SHELL STRUCTURE.

S.Sengupta and S.Ghosh.
Phys. Rev., Vol. 115, No. 6, 1681-2 (Sept. 15, 1959).

Energy levels for a three-dimensional bounded harmonic oscillator are obtained for intermediate distances of the boundary. Energy levels are found to depend on the dimensionless parameter $\rho_0 = (\omega M/\hbar)R^2$. ρ_0 is the ratio of the strength of the oscillator levels $(\hbar\omega)$ to that of the square well levels $(\hbar^2/MR^2)$. Adding a spin—orbit energy 30 times the Thomas value, nuclear energy levels are worked out for the two mass regions at A = 50 and 90. For $\rho_0 = 6$, good agreement with the experimental level sequence is obtained.

539.14

1363 LEVELS IN Zr^{90}: EXPERIMENTAL.

S.Bjørnholm, O.B.Nielsen and R.K.Sheline.
Phys. Rev., Vol. 115, No. 6, 1613-26 (Sept. 5, 1959).

The levels in Zr^{90} were studied by analysing the radiations of Nb^{90} in magnetic and scintillation spectrometers employing various coincidence techniques. Multipolarities of most of the transitions were determined from internal conversion coefficients and K—L ratios. A decay scheme (I) for Nb^{90} is proposed which assigns the following excited states in Zr^{90}: 1752 keV (0+), 2182 keV (2+), 2315 keV (5−), 3081 keV (4+), 3453 keV (6+), and 3595 keV (8+). Evidence is discussed for a few weak additional transitions potentially involving three additional levels (decay scheme II). Following the suggestion of Ford (Abstr. 8999 of 1955), the levels in decay scheme I are all interpreted as arising from the proton configurations $(p_{1/2})^2$, $(g_{9/2})^2$, and $(g_{9/2}p_{1/2})$. The half-life of the 3595 keV 8+ state has been experimentally determined as 3×10^{-7} sec, in good agreement with the half-life expected for a 141.5 keV E2 transition between 8+ and 6+ states, each involving a $(g_{9/2})^2$ configuration. The relative population of the two 9+ states of Zr^{90}, both by de-excitation of the 2+ state of that nucleus and by the β-decay of Y^{90}, indicates that these states result from highly mixed $(p_{1/2})^2$ and $(g_{9/2})^2$ configurations. Hindrance factors for several transitions indicate that the other positive parity states are largely generated from the $(g_{9/2})^2$ configuration. (See also following abstract).

539.14

1364 LEVELS IN Zr^{90}: THEORETICAL.

B.F.Bayman, A S.Reiner and R.K.Sheline.
Phys. Rev., Vol. 115, No. 6, 1627-35 (Sept. 15, 1959).

An attempt is made to describe the seven levels of Zr^{90} below 3.6 MeV in terms of the proton configurations $(2p_{1/2})^2$, $(2p_{1/2}1g_{9/2})^2$ The level positions and the compositions of the two 0+ states are determined for Gaussian and Yukawa forces of various ranges and exchange characters. The experimental data are well reproduced for a reasonable choice of the force parameters, the best fit being obtained with a Serber exchange mixture and a range of about 1.5 fermis. The experimental values of the half-lives of the excited states can also be reconciled with these simple configurational assignments. The most serious discrepancy is in the half-life of the first excited (0+) state, which is calculated to be 1.35×10^{-8} sec, as compared to the observed value of $(6.0 \pm 1.5) \times 10^{-8}$ sec. The remaining discrepancies in the energies and half-lives are in the direction of the effects produced by a slight deformation of the Sr^{88} core.

539.14

1365 NUCLEAR BAND STRUCTURE IN Sc^{41}.
R.H.Davis.

Phys. Rev., Vol. 115, No. 6, 1679-80 (Sept. 15, 1959).

Band structure predictions assuming the formation of proton single-particle states above the Ca^{40} core in the ground state or one of its excited states are compared with the available data on the elastic and inelastic scattering of the protons from Ca^{40}. The band expected above the 3.35 MeV state in Ca^{40} is confirmed by experimental results and some evidence is found for bands above the higher core states.

539.14

1366 TWO-QUANTUM TRANSITIONS IN ISOMERIC NUCLEI.
J.Eichler and G.Jacob.

Z. Phys., Vol.157, No.3, 206-300 (1959). In German.

Two-quantum emissions in nuclei proceed with such a small probability that they can hardly be detected unless all competing processes are strongly suppressed. Most favourable would be an excited level that can decay only by a $0^+ - 0^-$ transition but, unfortunately, such a case is not yet known. Another possibility for detecting two-quantum transitions might be provided by nuclear isomerism. An isomeric single quantum transition of a high multipolarity may be replaced by the emission of two quanta of lower multipolarities. The calculated angular correlation is generally not symmetric about 90^0. The total transition probability and the distribution of energy between the two quanta have been evaluated using the single particle model. The experimental possibility of observing two-quantum processes is discussed.

539.14

1367 NUCLEAR RESONANCE FLUORESCENCE IN Ce^{140}.
S.Ofer and A.Schwarzschild.

Phys. Rev., Vol. 116, No. 3, 725-9 (Nov. 1, 1959).

Measurements of the lifetime of the 1.6 MeV first excited state of Ce^{140} were performed using the nuclear resonance fluorescence method. Self-absorption experiments using Ce metal and CeO_2 scatterers and absorbers performed at 300^0 and 78^0K yield a mean life of $(1.10 \pm 0.15) \times 10^{-13}$ sec for this state. Formulae are presented for the analysis of resonance fluorescence experiments using thick scatterers and absorbers.

539.14

1368 NUCLEAR RESONANCE ABSORPTION OF γ-RAYS IN Ir^{191}.
R.L.Mössbauer.

Z.Naturforsch., Vol. 14a, No. 3, 211-16 (March, 1959). In German.

Discusses the appearance of strong spectral lines in the emission and absorption of soft γ-radiation by nuclei at low temperatures. The lines appear to be the consequence of a partial sharing of the γ-recoil momentum by the crystal lattice as well as by the individual nuclei. The superposition of emission and absorption lines produces a strong resonance fluorescence effect; this is suppressed by a "centrifuge" method whereby the emission and absorption lines are shifted relative to each other. The first series of measurements employing this method give a lifetime $\tau = (1.4 {}^{+0.2}_{-0.1}) \times 10^{-10}$ secs for the 129 KeV level in Ir^{191}. S.J.St-Lorant

539.14

1369 LIFETIMES OF 2^+ ROTATIONAL STATES.
M.Birk, G.Goldring and Y.Wolfson.

Phys. Rev., Vol. 116, No. 3, 730-3 (Nov. 1, 1959).

The mean lives of the rotational 2^+ states of nuclei in the region $150 \leq A \leq 186$ were measured with a pulsed proton beam timing device. The presence of prompt proton bremsstrahlung requires more elaborate analysis of the time distributions than the customary determination of centre of gravity shift. In order to achieve the necessary accuracy and freedom from drift, a beam switching procedure was introduced, alternating the beam between two targets and therefore allowing accurate comparisons to be made A measurement of the mean life of B^{10}, carried out as a check, yielded results in good agreement with previous measurements. A method for utilizing the lifetime measurements for accurate determinations of B(E2) values is discussed.

539.14

1370 ELECTRON CAPTURE DECAY OF Lu^{173} TO LEVELS IN Yb^{173}.
J.W.Bichard, J.W.Mihelich and B.Harmatz.

Phys. Rev., Vol. 116, No. 3, 720-4 (Nov. 1, 1959).

The electron capture of Lu^{173} (1.30 yr) to levels in Yb^{173} was investigated using scintillation spectrometers and permanent magnet spectrographs. Levels in Yb^{173} were observed at 78.7 (7/2−), 179.5 (9/2−), 351.2 (7/2+), and 636.8 (7/2−) keV. The first two excited states may be interpreted as members of a rotational band based on the ground state [(512) 5/2−]. The levels at 351 and 637 keV are probably the intrinsic levels [(633) 7/2+] and [(514) 7/2−], respectively, predicted by Nilsson. L electron capture was observed to be the primary mode of population of the 637 keV level. Relative reduced probabilities were obtained for all transitions to the ground-state rotational band, and comparisons with theoretical branching ratios were made. Log (ft) values were estimated from the observed K-capture branching ratios.

539.14

1371 ON THE EXISTENCE OF THE HYPERNUCLEUS $^6He_\Lambda$.
L.H.Schick.

Nuovo Cimento, Vol. 14, No. 2, 426-34 (Oct. 16, 1959).

Hypernuclei were observed for all $2 < A \leq 9$ with the exception of A = 6. The lack of observation of both ${}_\Lambda He^6$ and ${}_\Lambda Li^6$ implies that the binding energies of these hypernuclei either are negative, or are positive but less than that of ${}_\Lambda He^5$ so that if formed they decay immediately into ${}_\Lambda He^5$ + nucleon, or are greater than that of ${}_\Lambda He^5$ in which case their ultimate observation would be expected. The ${}_\Lambda He^6$ hypernucleus is analysed to determine in which of these three regions its binding energy lies. This analysis is carried out under the assumption that ${}_\Lambda He^6$ is a bound system, Λ + (neutron + α). A variation calculation using phenomenological potentials yields a lower bound of (2.00 ± 0.60) MeV for the total binding energy of ${}_\Lambda He^6$. This indicates that both ${}_\Lambda He^6$ and ${}_\Lambda Li^6$ are unstable against decay into ${}_\Lambda He^5$ + nucleon and are therefore not expected to be observed.

539.14

1372 OBSERVATION OF He^4 HYPERFRAGMENTS FROM K^-—He INTERACTIONS; THE $K^- - \Lambda$ RELATIVE PARITY.
M.M.Block, E.B.Brucker, I.S.Hughes, T.Kikuchi, C.Meltzer, F.Anderson, A.Pevsner, E.M.Harth, J.Leitner and H.O.Cohn.

Phys. Rev. Letters, Vol. 3, No. 6, 291-2 (Sept. 15, 1959).

Four events of the type $K^- + He^4 \rightarrow He^4_\Lambda + \pi^-$ were found in a liquid helium bubble chamber. Using certain assumptions, the observation of this reaction requires that the $K^- - \Lambda$ parity be negative. C.J.Batty

RADIOACTIVITY

539.16

1373 DETERMINING THE RADIOACTIVITY IN EARTH, WATER AND AIR. II.
H.Israël.

Arch. tech. Messen, No. 279, (Ref. V655-4), 69-72 (April, 1959). In German.

For Pt I, see Abstr. 13973 (1959). The three types of emanometer due to Becker, Janitzky and Israël are briefly described, and their maximum sensitivities given. Indirect methods of measurement utilizing disintegration products are discussed; these include methods of concentration, methods based on accumulation of +ve charges, the Aliverti method using electrostatic precipitation, and mechanical filtering methods. Radioactive coatings can be analysed by measuring the radiation emitted and its alteration with time. Counting and identification of emissions by means of counting tubes is briefly discussed.

539.16 : 517.5

METHOD FOR THE ANALYSIS OF MULTICOMPONENT EXPONENTIAL DECAY CURVES. See Abstr. 821

539.16

1374 MEASUREMENT OF THE ACTIVITY OF PREPARATIONS WHICH DECAY AS A RESULT OF ELECTRON CAPTURE.
A.A.Konstantinov.

Pribory i Tekh. Eksper., 1959, No. 1, 67-9 (Jan.-Feb.) In Russian.

The activity was measured by means of a 4π counter; it was determined from the number of the characteristic X-ray quanta emitted by the daughter element. F.Lachman

539.16

1375 INVESTIGATIONS OF THE DECAY OF ^{185}W.
B.P.Singh and H.S.Hans.

Nuovo Cimento, Vol. 14, No. 1, 108-13 (Oct. 1, 1959).

The half life of 57 keV electromagnetic radiation as obtained in the γ-ray spectrum of the decay of W^{185} was measured to be (140 ± 5) days. The 57 keV radiation has, therefore, been assigned to W^{181}. Two more γ-rays of low intensity have been observed at 136 keV and 152 keV. By energy and intensity considerations, these γ-rays are also considered to be due to W^{181}. The maximum energy of the β-ray group was measured to be (420 ± 20) keV. No genuine coincidences were found between any part of β-ray spectrum and γ-rays and also no γ—γ coincidences were found. Neither the γ-ray of 125 keV (0.005%) nor any inner β-ray group can be assigned to the spectrum of W^{185}.

539.16

1376 FURTHER WORK ON THE DECAY OF THALLIUM 202.

S.Jha and H.G.Devare.

Nuovo Cimento, Vol. 14, No. 3, 509-15 (Nov. 1, 1959).

Radiations from 12 day Tl^{202} were studied in scintillation coincidence spectrometers. In addition to the well-known γ-ray of 440 keV energy, a very low intensity γ-ray of energy 960 keV was found showing that the electron capture decay of Tl^{202} leads to the 440 keV and 960 keV states of Hg^{202}. By the "sum-coincidence" technique and the conventional coincidence technique, it is shown that the 960 keV state de-excites also by the cascade emission of 440 keV and 520 keV γ-rays. By measuring the ratio of the number of captures from the K shell and that from L, M ... shells, the decay energy of Tl^{202} is calculated to be (980^{-60}_{+760}) keV.

539.16

1377 DECAY SCHEMES OF THE ISOMERS OF Tc^{95} AND Tc^{97}.

J.P.Unik and J.O.Rasmussen.

Phys. Rev., Vol. 115, No. 6, 1687-92 (Sept. 15, 1959).

The decay schemes of Tc^{95} and Tc^{97} were investigated using high-resolution conversion-electron spectrographs, gamma-ray scintillation detectors, and coincidence techniques. In addition to the 38.9 keV isomeric transition in Tc^{95}, eight transitions of the following energies are assigned to Mo^{95}: 204.2, 583.9, 763, 767.9, 784, 788.0, 822.5, and 837.3 keV. A decay scheme is proposed. The isomer of Tc^{97} is shown to decay by a single M4 transition of 96.5 ± 0.1 keV. The experimental K : L : M relative conversion-electron intensities for this transition are 1 : 0.48 : 0.13.

539.16

1378 RADIOACTIVE DECAY OF Dy^{159}.

B.H.Ketelle and A.R.Brosi.

Phys. Rev., Vol. 116, No. 1, 98-101 (Oct. 1, 1959).

Decay of Dy^{159} is shown to feed three excited levels in Tb^{159}. Gamma rays with energies of 58, 200, 290 and 350 keV were observed and electron-capture branching ratios were determined. Only L electron capture to the 350 keV level was detected. The half-life of the 58 keV level in Tb^{159} was shown to be less than 1×10^{-9} sec. The K conversion coefficient of the 58 keV gamma ray was measured and found to be 5 ± 1.5. The disintegration energy of Dy^{159} was shown to lie between 360 and 400 keV; the half-life was remeasured and found to be 144.4 ± 0.2 days.

539.16

1379 Tb^{150}: A NEW TERBIUM ISOTOPE.

K.S.Toth, S.Bjørnholm, M.Jørgensen, O.B.Nielsen and O.Skilbreid.

Phys. Rev., Vol. 116, No. 1, 118-19 (Oct. 1, 1959).

A new isotope with a 3.1 hr half-life was produced in a 60 MeV proton bombardment of natural gadolinium. The isotope was identified to be Tb^{150} by means of a mass separation performed on the chemically purified terbium fraction. Gamma-ray spectra revealed an intense 640 keV peak belonging to Tb^{150} decay. The γ-ray is probably the transition from the first-excited to the ground state in Gd^{150}.

539.16

1380 DECAY OF U^{240} AND 7.3 MIN Np^{240}.

M.E.Bunker, B.J.Dropesky, J.D.Knight, J.W.Starner and B.Warren.

Phys. Rev., Vol. 116, No. 1, 143-53 (Oct. 1, 1959).

The radiations of U^{240} and 7.3 min Np^{240} were studied with a solenoidal beta spectrometer, beta- and gamma-scintillation spectrometers, and 180° permanent-magnet spectrographs. The principal decay branch of U^{240} is a 0.36 MeV beta transition to the 7.3 min state of Np^{240}. The only other radiations observed which are attributed to U^{240} are the conversion lines associated with a 0.044 MeV transition. The decay scheme of 7.3 min Np^{240} is considerably more complicated than that indicated by previous investigations. On the basis of coincidence studies, intensity data, internal conversion coefficients, and the measured transition energies, a consistent level scheme for Pu^{240} is proposed which has excited states at 0.043, 0.142, 0.597, 0.858, 0.900, 0.942, 1.42, 1.53, and 1.62 MeV. The ground-state transition from the 0.858 MeV level is of E0 multipolarity, identifying this level as a 0+ state. There are beta transitions to the ground state of Pu^{240} (Q_β = 2.18 MeV) and to each of the above excited states except the one at 0.142 MeV. Consideration of the beta-decay information leads to a spin and parity assignment of 1+ for 7.3 min Np^{240}. Various features of the decay scheme are compared with the predictions of current models of nuclear structure.

539.16

1381 MASS ASSIGNMENTS AND SOME DECAY CHARACTERISTICS OF Gd^{145}, Eu^{145}, Gd^{146}, AND Eu^{146}.

J.R.Grover.

Phys. Rev., Vol. 116, No. 2, 406-12 (Oct. 15, 1959).

The nuclides Gd^{145}, Eu^{145}, Gd^{146}, and Eu^{146} were prepared by the interactions of 20 to 40 MeV helium ions with Sm^{144}, and found to decay with half-lives of 25 ± 2 min, 5.6 ± 0.3 days, 46 ± 2 days, and 4.4 ± 0.1 days, respectively. The mass number assignments were made on the basis of excitation functions, and chemical evidence of parent—daughter relationships, with special reference to the previously known nuclide Eu^{145}. The most prominent gamma rays appearing in the decay of each of these four nuclides are as follows: in Gd^{145} decay, at 0.80, 1.03, and 1.75 MeV; in Eu^{145} decay, at 0.53, 0.64, and 0.89 MeV; in Gd^{146} decay, at 0.114 and 0.153 MeV; and in Eu^{146} decay, at 0.63 and 0.74 MeV. There is also a strong K X-ray line in each spectrum. In addition, Gd^{145} was found to emit positrons with an end-point energy of about 2.4 ± 0.2 MeV.

539.16

1382 NEW SHORT-LIVED ISOMERIC STATES As^{75m} AND Ga^{70m} FORMED WITH FAST PROTONS.

A.M.Morozov and P.A.Yampol'skii.

Zh. eksper. teor. Fiz., Vol.36, No.3, 950-1 (March, 1959). In Russian.

Pulsed protons of 19.6 MeV are used. Previous and new results are as follows: As^{75m}; $E\gamma = 0.30 \pm 0.01$ MeV, $T_{1/2} = 16 \pm 1$ ms Ga^{70m} from reaction Ga^{71} (p,pn) Ga^{70m}; $E\gamma = 0.19$ MeV ± 0.01 $T_{1/2} = 19 \pm 1$ ms. [English summary: PB 141052T-11, obtainable from Office of Technical Services, U.S.Dept of Commerce, Washington,D.C., U.S.A.]. J.Lascoux

539.16

1383 ALPHA-DECAY BARRIER PENETRABILITIES WITH AN EXPONENTIAL NUCLEAR POTENTIAL: ODD-MASS NUCLEI.

J.O.Rasmussen.

Phys. Rev., Vol. 115, No. 6, 1675-9 (Sept. 15, 1959).

Barrier penetrabilities, reduced widths, and hindrance factors for odd-mass α-particle emitters are calculated using the diffuse exponential nuclear potential derived from optical-model analysis of α elastic-scattering data. The calculations are made on the same basis as for even—even α-emitters (see Abstr. 7322 of 1959).

539.16

1384 THEORETICAL STUDIES OF THE ALPHA DECAY OF U^{233}.

R.R.Chasman and J.O.Rasmussen.

Phys. Rev., Vol. 115, No. 5, 1257-63 (Sept. 1, 1959).

The alpha decay of a deformed odd-mass nucleus, U^{233}, is treated by the use of numerical integration on an IBM-650 computer. The results of this treatment are compared with the theory of Bohr, Fröman, and Mottelson (Abstr. 6425 of 1955). Approximate analytic methods are developed for predicting the intensities of the higher members of the ground rotational band. A comparison is made between the numerical integration and the experiments of Roberts, Dabbs, and Parker [Oak Ridge National Laboratory Report ORNL-2204, 1956 (unpublished), p. 60], in which they examine the angular distribution of alpha particles from aligned U^{233} nuclei. The results of the numerical integration of U^{233} are presented in matrices analogous to those of Fröman, and numerical values of the functions are given for selected values of r.

539.16

1385 DETERMINATION OF THE BETA-DECAY INTERACTION FROM ELECTRON—NEUTRINO ANGULAR CORRELATION MEASUREMENTS.

J.S.Allen, R.L.Burman, W.B.Herrmannsfeldt, P.Stähelin and T.H.Braid.

Phys. Rev., Vol. 116, No. 1, 134-43 (Oct. 1, 1959).

The angular correlation coefficients in the allowed beta decays of He^{6}, Ne^{19}, Ne^{23}, and A^{35} were experimentally determined from measurements of the energy spectra of the recoil ions. The form of the beta-decay interaction were deduced from these measurements. The experimental results are summarized in the following table together with the beta-decay interaction forms which are indicated by each measurement.

Isotope	Selection rules	Correlation coefficient	Interaction forms
He^6	G-T	−0.39 ± 0.05	A
Ne^{19}	F and G-T	0.00 ± 0.08	ST or VA
Ne^{23}	G-T	−0.37 ± 0.04	A
A^{35}	Mostly F	+0.97 ± 0.14	VT or VA

It is apparent from the last column that the experimental results are consistent if it is assumed that the dominant beta-decay interaction is the VA combination.

539.16

1386 ON THE BETA DECAY OF URANIUM X2.

H.Schneider, P.W.de Lange and J.W.L.de Villiers.
Nuovo Cimento, Vol. 14, No. 1, 11-28 (Oct. 1, 1959).

The β- and γ-ray spectra observed in the decay of UX2 (1.175 min half-life in Pa^{234}) are investigated. β–γ-coincidences, obtained in a β-ray spectrometer, as well as γ–γ-coincidence measurements with selected energies are described. In the β-spectrum 11 partial spectra, leading to different states in the daughter nucleus U^{234}, are resolved and their log ft values are given. The high-energy part of this spectrum, which was always assumed to go to the ground state, is shown to be highly complex containing 5 partial spectra. The log ft value of the ground state transition is found to be 6.9, indicating the same degree of forbiddenness as observed for the transition $Th^{234}–Pa^{234}$. Spin assignment is made to UX2 and some excited states in U^{234}. A decay scheme is presented.

539.16 : 550.9

1387 HALF-LIFE AND BETA SPECTRUM OF Rb^{87}.

K.F.Flynn and L.E.Glendenin.
Phys. Rev., Vol. 116, No. 3, 744-8 (Nov. 1, 1959).

Liquid-scintillation counting techniques were used to measure the specific activity and beta spectrum of the natural radioactivity of rubidium. An accurate value for the decay constant of Rb^{87} is of considerable interest in the measurement of the ages of geological specimens. The measured Rb^{87} half-life is (47.0 ± 10) × 10^9 yr, and the observed maximum beta energy is 272 ± 3 keV.

539.16

1388 THE DECAY OF ^{44}Ti.

E.W.Cybulska and L.Marquez.
Nuovo Cimento, Vol. 14, No. 3, 479-83 (Nov. 1, 1959).

The decay was studied with scintillation spectrometers, coincidences and delayed coincidences. It was found that Ti^{44} decays by electron capture to the second excited state of Sc^{44}. This is followed by a γ-ray of 79 keV and then a γ-ray of 70 keV. The 70 keV state is metastable with a half-life of 0.18 μsec.

539.16

1389 SEARCH FOR POSITRON EMISSION IN K^{40}.

D.R.Tilley and L.Madansky.
Phys. Rev., Vol. 116, No. 2, 413-15 (Oct. 15, 1959).

A search for positron emission in K^{40} was made with the use of a triple coincidence technique. An upper limit of (3.6 ± 1.8) × 10^{-4} positrons per sec per gram of natural potassium has been set. A corresponding upper limit of 0.59 ± 0.28 has been computed for the ratio of the squares of the matrix elements, M_+^2/M_-^2, for the K^{40} β^+ and β^- transitions.

539.16

1390 NUCLEAR ORIENTATION IN RADIATIVE K CAPTURE.

V.B.Berestetskii.
Zh. eksper. teor. Fiz., Vol. 35, No. 2 (8), 537-8 (Aug., 1958).
In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 35 (8), No. 2, 371 (Feb., 1959).

The polarization density matrix of the daughter nucleus in radiative capture processes is calculated and the nuclear orientation deduced. S.J.St-Lorant

539.16

1391 INVESTIGATION OF DIRECTION CORRELATION IN THE γ-RADIATION OF Cd^{110}.

U.Cappeller and E.Ganssauge.
Z. Phys., Vol. 153, No. 5, 592-608 (1959). In German.

Associated with the β-decay of Ag^{110m} are γ-radiations of several different energies, from the excited Cd^{110} levels. The direction correlation of these γ-radiations was observed by two scintillation spectrometers connected in coincidence. A technique is described for sorting out the fractions of the coincidence rates related to each type of cascade. As a result of this, the spin quantum numbers and the probable parities could be given for the 1539, 2484 and 2920 keV levels of Cd^{110}. D.H.Lord

539.16

1392 COINCIDENCE STUDIES OF THE RADIATIONS FROM THE DECAY OF ^{182}Ta.

B.P.Singh, H.S.Hans and P.S.Gill.
Nuovo Cimento, Vol. 14, No. 1, 99-107 (Oct. 1, 1959).

Gamma-rays at 68 keV, 100 keV, 152 keV, 1.122 MeV, 1.189 MeV, and 1.222 MeV have been found in the decay of Ta^{182} using a scintillation spectrometer. The γ-ray of 68 keV is found to be in coincidence with 57 keV, 100 keV, 264 keV, 1.122 MeV and 1.222 MeV energy γ-rays. The γ-ray of 152 keV is found to be in coincidence with 57 keV, 100 keV, 1.122 MeV and 1.222 MeV energy γ-rays and also the 222 keV γ-ray is found to be in coincidence with 57 keV, 100 keV and 1.231 MeV energy γ-rays. Two β-ray groups of maximum energy of (560 ± 50) keV and (460 ± 40) keV have been found by coincidence studies. These coincidence studies have established the levels at 100 keV, 1.222 MeV, 1.290 MeV, 1.331 MeV, 1.374 MeV and 1.554 MeV in W^{182}.

539.16

1393 LOW-ENERGY CAPTURE GAMMA RAYS OF Eu^{152} AND Eu^{154}. E.T.Patronis, Jr and H.Marshak.

Phys. Rev., Vol. 115, No. 5, 1287-9 (Sept. 1, 1959).

The low-energy capture gamma-rays spectra were examined up to an energy of 300 keV by the use of a scintillation spectrometer. Eu^{152} was found to exhibit lines at 81 ± 4 and 92 ± 3 keV while Eu^{154} exhibited gamma lines at 75 ± 3 and 91 ± 3 keV. Coincidence measurements were made on a composite spectrum produced by thermal neutron capture in natural Eu. The data are consistent with the interpretation that the Eu^{154} lines are members of a rotational band while the Eu^{152} lines are not.

539.16

1394 POLARIZATION OF γ RAYS IN Pb^{207}.

P.H.Stelson, W.G.Smith and F.K.McGowan.
Phys. Rev., Vol. 116, No. 1, 167-9 (Oct. 1, 1959).

Polarization-direction measurements were made on the γ-ray transitions in Pb^{207} resulting from the decay of Bi^{207}. These measurements were made to obtain additional information on both the spin of the level at 2.34 MeV and the multipole character of the decay γ-ray. The observed polarization eliminates the possible spin assignment 9/2. It is concluded that the spin assignment is 7/2 and that the 1.77 MeV γ-ray is predominantly M1.

NUCLEAR REACTIONS

539.17

1395 SURFACE COUPLING MECHANISM FOR APPROACHING STATISTICAL EQUILIBRIUM IN COMPOUND NUCLEUS FORMATION, WITH APPLICATION TO FISSION. L.Wilets.

Phys. Rev., Vol. 116, No. 2, 372-82 (Oct. 15, 1959).

In a particular representation where the state vectors are not eigenstates of the Hamiltonian, coupling terms remain which cause "virtual" or "real" transitions among states. An appropriate choice of representation depends upon the physical processes involved. The decay of a compound nucleus, especially by fission, is considered. The strong coupling representation of the unified model is employed, with surface oscillations inducing transitions among states of the representation. A diffusion equation is derived to describe the flow of probability among the states available within constraints. An estimate of the characteristic relaxation time for arriving at statistical equilibrium is obtained. Only when the relaxation time is short compared with a basic reaction time are statistical arguments valid to evaluate the reaction rate. As an example the relevant reaction time in the fission process is a collective vibrational period. The necessary condition appears to be satisfied for excitation energies more than a few MeV above threshold. Arguments are presented to show why equilibrium may not be maintained at lower energy. Thus the usual estimate of the number of open channels, $2\pi\overline{\Gamma}_f/D$, would give a number lower than what one would estimate simply from penetrability of the fission barrier. This seems to explain, at least in part, the anomalously low numbers of channels obtained in this manner. Problems relating to the validity of often-made statistical assumptions at scission are also discussed.

539.17

1396 REACTION MECHANISM IN DIRECT INTERACTION INELASTIC SCATTERING. B.L.Cohen.

Phys. Rev.,Vol.116, No.2, 426-7 (Oct. 15, 1959).

It is pointed out that experimental results indicate very striking similarities between (p,p') and (d,d') reactions, and very striking differences between (p,p') and (p,n) reactions. It is shown that this is in strong disagreement with the nucleon—nucleon collision model commonly used in interpreting (p,p') reactions, but in agreement with the recent inelastic diffraction scattering model of Blair. (Abstr. 432 of 1960).

539.17

1397 MONTE CARLO CALCULATIONS OF NUCLEAR EVAPORATION PROCESSES. III. APPLICATIONS TO LOW-ENERGY REACTIONS.

I.Dostrovsky, Z.Fraenkel and G.Friedlander.

Phys. Rev., Vol. 116, No. 3, 683 (Nov. 1, 1959).

For Pt I see Abstr. 3884 (1959). For Pt II see Dostrovsky, Fraenkel and Rabinowitz, Proceedings of the Second International Conference on the Peaceful Uses of Atomic Energy, Geneva, 1958, Paper 1615. Monte Carlo calculations of nuclear reactions in the low-energy ($E < 50$ MeV) region are described. The calculations are based on the nuclear evaporation model of Weisskopf. Continuum theory was used for the calculation of inverse reaction cross-sections. In the calculation of the level densities of excited nuclei, pairing and shell energy corrections were used in terms of characteristic level displacements. The accurate equation rather than the approximate Maxwell distribution was used for the selection of the kinetic energy of the evaporated particle. Experimentally determined Q-values for the various reactions were used. The calculations are compared with experimental measurements for about 60 excitation functions of nuclear reactions in the mass range Cr^{50}-Se^{74}. Cameron's values for pairing energies were used at the outset; but a new set of pairing and shell energy correction values, which leads to substantially improved agreement with the experimental curves, is presented. The procedure which was used to arrive at this set is described and several features of the set are discussed. The need for a further downward correction of the level density of symmetrical ($A=2Z$) nuclei is indicated. Computed excitation functions are shown for all the reactions studied as well as for several reactions for which experimental data are not yet available. Further experiments on reaction cross-sections are suggested which would allow a unique determination of the pairing and shell energy corrections of level densities for any value of Z and N in the region under discussion. The existence of a unique set of these correction terms would provide strong evidence for the validity of evaporation theory for the reactions considered.

539.17 : 537.54 : 621.319.32

THE STUDY OF THE RESONANCE CAPTURE OF 1-2 MeV PROTONS BY Mg^{25} AND Mg^{26}. See Abstr. 1175

539.17

1398 STUDIES OF (p,n) REACTIONS IN THE PROTON ENERGY RANGE FROM 2 TO 10 MeV.

D.A.Bromley, A.J.Ferguson, H.E.Gove, J.A.Kuehner, A.E.Litherland, E.Almqvist and R.Batchelor.

Canad. J. Phys., Vol. 37, No. 12, 1514-47 (Dec., 1959).

Reaction thresholds have been studied for (p,n) reactions on B^{11}, F^{19}, Al^{27}, Si^{30}, P^{31}, K^{39}, Ni^{58}, and Ni^{60}. Using the $C^{13}(p,n)N^{13}$ and $Cu^{65}(p,n)Zn^{65}$ thresholds, which have previously been measured with precision, to calibrate the magnetic beam analyser of the tandem accelerator, and the $H^2(O^{16},n)F^{17}$ threshold to establish the linearity of this calibration to an equivalent proton energy of 14.57 MeV, threshold energies of 3.019 ± 0.004, 4.229 ± 0.006, 5.800 ± 0.008, 5.174 ± 0.030, 6.456 ± 0.020, 7.227 ± 0.070, 9.480 ± 0.025 and 7.016 ± 0.015 MeV, respectively, have been established. These data are in reasonable agreement with the available positron decay data except in the case of Ca^{39} where an unexplained discrepancy exists. Resonances of total width less than 20 keV have been observed in the neutron-excitation curves of the $Al^{27}(p,n)Si^{27}$ and $Si^{30}(p,n)P^{30}$ reactions corresponding to excitations of approximately 17 MeV and 13 MeV in the compound systems Si^{28} and P^{31}, respectively. In the latter case isolated resonances are found without overlapping broad resonances. The reaction threshold falls between resonances and is not directly observable; the counter-ratio technique was calibrated for use in such situations.. Neutron yield measurements have been made on thick targets of C, Al, $Ni^{60}O$, $Ni^{58}O$, Ni^{58}, W, Pb, Au, Th, and U as functions of the incident proton energy in the energy range from 4 to 10 MeV.

539.17

1399 HIGH ENERGY NUCLEAR DISINTEGRATIONS.

E.Tamai.

Nuovo Cimento, Vol. 14, No. 1, 1-10 (Oct. 1, 1959).

The disintegrations of heavy nuclei (Ag or Br) in emulsion were examined. These disintegrations were produced by the proton beam (6.2 GeV) of the Berkeley bevatron. The probabilities of emission of protons, α-particles, Li, Be, B, and C fragments from stars at given excitation energies were investigated, and these experimental results are compared with those calculated by the evaporation theory.

539.17

1400 ELASTIC SCATTERING AND POLARIZATION OF HIGH-ENERGY NUCLEONS BY NUCLEI.

A.M.Saperstein and D.Feldman.

Nuovo Cimento, Vol. 14, No. 3, 457-78 (Nov. 1, 1959).

The cross-section and polarization for the elastic scattering of protons by carbon and lead at 135 MeV and by carbon at 300 MeV have been evaluated in the impulse approximation using the nucleon—nucleon phase-shift sets of Signell—Marshak, Gammel—Thaler, Ohnuma—Feldman, and Stapp. The detailed calculations have been carried out both in ordinary Born approximation and also in terms of a modified Born approximation,in which account is taken of the absorption of the elastically scattered nucleon wave within the nucleus. Relativistic effects have been estimated and have been found to be small. The possibility of distinguishing among the various sets of nucleon—nucleon phase shifts is discussed.

539.17

1401 ON THE PROBLEM OF ANGULAR CORRELATION OF SECONDARY PARTICLES PRODUCED IN HIGH-ENERGY NUCLEAR COLLISIONS.

I.M.Gramenitskii, M.Ya.Danysh, V.B.Lyubimov, M.I.Podgoretskii and D.Tuvdéndorzh.

Zh. eksper. teor. Fiz., Vol. 35, No. 2(8), 552-3 (Aug., 1958). In Russian. English translation in : Soviet Physics—JETP (New York), Vol. 35(8), No. 2, 381-2 (Feb., 1959).

Reports on the measurement of a correlation coefficient between the number of particles emitted within various solid angles, in reactions involving ~ 9 GeV protons with emulsion nuclei. The results indicate that the directions of emission of secondary particles are not entirely independent statistically. S.J.St-Lorant

539.17

1402 RECOIL RANGE OF Na^{24} AND THE MECHANISM OF $Al^{27}(p,3pn)$,$Si^{28}(p,4pn)$, AND $P^{31}(p,5p3n)$ FOR 660 MeV PROTONS.

L.V.Volkova and F.P.Denisov.

Zh. eksper. teor. Fiz., Vol. 35, No. 2(8), 538-9 (Aug., 1958). In Russian. English translation in : Soviet Physics—JETP (New York), Vol. 35(8), No. 2, 372-3 (Feb., 1959).

The Serber model of high energy nuclear reactions predicts about twice the observed recoil ranges. These are consistent with a picture of the incident proton interacting with a group of nucleons whose momenta are correlated so that their sum is less than 5 $(MeV)^{1/2}$ in Al, or 3.2 $(MeV)^{1/2}$ in Si and 5.5 $(MeV)^{1/2}$ in P. (Momenta measured in units of $[ME/m]^{1/2}$, M being the nuclear and m the nucleon mass). D.W.L.Sprung

539.17

1403 RANGES OF Na^{24} RECOIL NUCLEI AND THE MECHANISM OF CERTAIN PHOTONUCLEAR REACTIONS.

F.P.Denisov and P.A.Cherenkov.

Zh. eksper. teor. Fiz., Vol. 35, No. 2(8), 544-6 (Aug., 1958). In Russian. English translation in : Soviet Physics—JETP (New York), Vol. 35(8), No. 2, 376-7 (Feb., 1959).

The effective thickness t of specimens of Al, Si, and S to Na^{24} recoil nuclei has been measured after bombardment by photons of maximum energy 260 MeV. For Al the measurement was repeated at 200, 150, 100, and 80 MeV. The results are inconsistent with formation of a compound nucleus and subsequent evaporation; but also disagree with the "quasi-deuteron" model where the incoming photon excites a pair of nucleons leading to intranuclear cascade and finally evaporation. D.W.L.Sprung

539.17

1404 RADIATIVE CAPTURE OF PROTONS BY Be^9.

W.E.Meyerhof, N.W.Tanner and C.M.Hudson.

Phys. Rev., Vol. 115, No. 5, 1227-37 (Sept. 1, 1959).

For previous work see Abstr. 2754 (1959). The gamma rays from the capture in Be^9 of protons of energy between 0.27 and 1.2 MeV were studied using large scintillation crystals. Excitation functions of the gamma rays leading to the 0, 0.72, 1.74, 2.15, 3.58, and 5.16 MeV states of Be^{10} were computed from the measured gamma-ray spectra. In addition to the resonances previously known to exist at 0.33, 0.99, and 1.086 MeV proton energy [corresponding to (1^-) 6.88, (2^-) 7.48, and (0^+) 7.56 MeV states in B^{10}], evidence was found only for the p-wave resonance near 1 MeV [(2^+) 7.5 MeV state in B^{10}] postulated by Mozer and Dearnaly and for the influence of higher lying states. This work leaves unexplained the large isotopic-spin impurity of the 6.88 MeV level. Appreciable nonresonant capture was found for the transitions to the 0, 0.72, 3.58, and 5.16 MeV states, which is probably not s-wave for the latter two transitions. Accurate energy measurements and coincidence work showed that the 5.16 MeV level of B^{10} is populated in preference to the 5.11 MeV level, contradicting earlier work of Clegg. Also, experimental evidence was found which appears to be in contradiction to the 0^+ spin assignment for the 7.56 MeV level of B^{10} and raises doubts about the 2^+ spin assignment of the 5.16 MeV level.

539.17

1405

INTERACTION OF YTTRIUM WITH PROTONS OF ENERGY BETWEEN 60 AND 240 MeV.

A.A.Caretto, Jr and E.O.Wiig.

Phys. Rev., Vol. 115, No. 5, 1238-42 (Sept. 1, 1959).

For previous work see Abstr. 6898 (1956). Absolute cross-sections are reported for a number of nuclides produced by the interaction with yttrium of protons of 60, 100, 150, 180, and 240 MeV. At low energies the yields can be accounted for by direct interaction or knock-on processes. At higher energies the knock-on cascade model together with evaporation appears to explain the observed yields.

539.17

1406

PRECISE DETERMINATION OF NUCLEAR REACTION ENERGIES AND MEASUREMENTS OF RESONANCE WIDTHS.

R.O.Bondelid and C.A.Kennedy.

Phys. Rev., Vol. 115, No. 6, 1601-12 (Sept. 15, 1959).

An electrostatic analyser with a radius of curvature of 2 m and a deflection angle of 90° was constructed and evaluated. It is used to provide an ion beam whose energy is precisely known and highly resolved. The absolute energy calibration is believed to be accurate to ±0.05%, and the inherent energy resolution is 0.01% per 0.010 in. of input slit separation. Proton bombarding energies were determined for (p,γ) reactions on F^{19} at 340.5 ± 0.3 keV, 483.6 ± 0.3 keV, 872.4 ± 0.4 keV; Al^{27} at 992.4 ± 0.5 keV; Ni^{58} at 1424.1 ± 0.7 keV, 1843.7 ± 0.9 keV; and C^{13} at 1747.6 ± 0.9 keV. Resonance widths were measured for these reactions. They are 2.4 ± 0.3 keV, 0.9 ± 0.1 keV, 4.5 ± 0.3 keV, 100 ± 50 eV, 100 ± 50 eV, and 75 ± 50 eV, respectively. The (p,n) thresholds were determined for Li^7 at 1881.2 ± 0.9 keV and C^{13} at 3237.2 ± 1.6 keV.

539.17

1407

COULOMB EXCITATION OF STATES IN Pt^{195}.

F.K.McGowan and P.H.Stelson.

Phys. Rev., Vol. 116, No. 1, 154-9 (Oct. 1, 1959).

Gamma rays of 99, 110, 130, 140, 210, and 240 keV were observed from Coulomb excitation of Pt^{195} (platinum target containing 60.1% Pt^{195}) with 3.0 to 5.5 MeV protons and α-particles. The energy dependence of the gamma-ray yields indicates direct excitation of states at 99, 130, 210, and 240 keV. The 140 keV gamma ray is a cascade transition between states at 240 and 99 keV. These results do not agree with the conclusions of Bernstein and Lewis (Abstr. 1544 of 1956) who measured the Coulomb excitation functions of the internal conversion electrons and found evidence for direct excitation of levels at 31 and 130 keV but no evidence for direct excitation of a level at 99 keV. The angular distributions of the 240 and 210 keV gamma rays and the 140 keV gamma ray in coincidence with K X-rays from internal conversion of the 99 keV transition were measured with respect to the incident ion beam on a thick target. These measured distributions are consistent with an assignment of 5/2(E2)1/2, 3/2(E2 + M1)1/2 with $(E2/M1)^{1/2} = 0.37 \pm 0.02$, and 5/2(E2 + M1)3/2 with $(E2/M1)^{1/2} = -(0.13 \pm 0.03)$ for the 240, 210, and 140 keV transitions, respectively. The B(E2) and B(M1) for decay of these states were determined.

539.17

1408

MEASUREMENT OF SPIN POLARIZATION BY NUCLEAR SCATTERING.

G.C.Phillips and P.D.Miller.

Phys. Rev., Vol.115, No.5, 1268-70 (Sept. 1, 1959).

Accurate measurements of differential cross-sections for elastic scattering of protons from He^4 and C^{12}, and of He^3 from He^4 in the energy range 2-6 Mev are phase-shift analysed and the expected spin polarization of scattered particles calculated. The results, plotted as contours of equal spin polarization versus energy and angle, should be useful in accurate measurements of spin polarization and in addition show a number of rather striking complexities due to interference effects.

539.17

1409

ELASTIC SCATTERING OF 20.35 MeV PROTONS BY Zn^{64}, Zn^{66}, AND Zn^{68}.

R.W.Boom and J.R.Richardson.

Phys. Rev., Vol. 115, No. 6, 1700-4 (Sept. 15, 1959).

The absolute differential cross-section for the elastic scattering of (20.35 ± 0.25) MeV protons was measured for enriched Zn^{64}, Zn^{66}, and Zn^{68} foils. In the angular range of 30°-160° about 50 measurements were made for each foil (spaced from 1° to 5°) to an estimated accuracy of about 5% standard deviation. Scattered protons were detected by nuclear emulsions wrapped around a 4 in. diameter scattering chamber, all angles being exposed simultaneously. Detector energy resolution is 2.5%, angular resolutions is 1° standard deviation, and relative angular shifts are determined to 0.1°. Correction has been made for the finite sizes of beam and detector and for multiple scattering in the target and in the detector stopper. The ± 0.25 MeV energy spread includes maximum and minimum energies due to beam drift, beam spread, and target foil thickness. Three minima are found for each isotope: Zn^{64} at 63°, 104°, 142°; Zn^{66} at 62°, 102.5°, 142°; and Zn^{68} at 61°, 101°, 142°. The absolute cross-sections are approximately the same except at the third minima, where for Zn^{64}, Zn^{66}, and Zn^{68} they are respectively, 1.46, 1.07, and 0.61 mb/sterad.

539.17

1410

ELASTIC SCATTERING OF PROTONS BY NITROGEN.

A.J.Ferguson, R.L.Clarke and H.E.Gove.

Phys. Rev., Vol.115, No.6, 1655-9 (Sept. 15, 1959).

Cross-sections were measured in 105 angular distributions ranging in angle from 53° to 155° and in energy from 1.05 to 2.93 MeV. Resonances were observed at 1065 ± 5, 1557 ± 6, 1743 ± 7, 1803 ± 7, 2344 ± 10, and 2468 ± 10 keV. (See also following abstract).

539.17

1411

PHASE-SHIFT ANALYSIS OF PROTON SCATTERING BY NITROGEN.

A.J.Ferguson.

Phys. Rev., Vol.115, No.6, 1660-4 (Sept. 15, 1959).

A phase-shift analysis was made of a set of angular distributions for the elastic scattering of protons by nitrogen in the energy range 1.0 to 3.0 MeV. Two independent S-wave phase shifts and one P-wave phase shift of hard-sphere type were assumed. Moderately good agreement with the nonresonant scattering below 2.3 MeV and with the scattering at the $\frac{1}{2}+$ resonance at 1.557 MeV was obtained, indicating that the gross features of the scattering can be represented in this way. Between 2.3 and 3.0 MeV the fits are poor. The results indicate a broad $\frac{1}{2}+$ resonance at 2.32 MeV with a width of 0.55 MeV.

539.17

1412

TOTAL REACTION AND ELASTIC SCATTERING CROSS SECTIONS FOR 22.8 MeV PROTONS ON URANIUM ISOTOPES.

C.B.Fulmer.

Phys. Rev., Vol. 116, No. 2, 418-23 (Oct. 15, 1959).

The total reaction cross-sections for 22.8 MeV protons on uranium isotopes were determined by measuring cross-sections for (p, fission), (p,p'), (p,d), (p,t), and (p,α). These data are combined with previously measured (p,xn) cross-sections to give total reaction cross-sections of 1.43 ± 0.10, 1.44 ± 0.10, and 1.39 ± 0.10, barns for 22.8 MeV protons on U^{233}, U^{235}, and U^{238}, respectively. Angular distributions of (p,p'), (p,d), (p,t), (p,α), and proton elastic scattering cross-sections are shown for U^{235} and U^{238}.

539.17

1413

ANGULAR DISTRIBUTIONS OF DEUTERONS FROM Li^7(p,d)Li^6 REACTIONS.

E.F.Bennett and D.R.Maxson.

Phys. Rev., Vol. 116, No. 1, 131-3 (Oct. 1, 1959).

Angular distributions of deuterons from Li^7(p,d)Li^6 reactions induced by 17.5 MeV protons on a natural lithium target were observed at angles less than 50° in the laboratory system. Deuteron groups leaving Li^6 in its ground state and in states at 2.19 and 3.57 MeV were studied, and the branching ratios were compared with intermediate coupling shell theory. Pure or nearly pure L-S coupling was found to be adequate to explain the observed ratios.

539.17

1414 TOTAL CROSS-SECTION OF STRIPPING AND DIFFRACTION DISINTEGRATION OF FAST DEUTERONS ON NON-SPHERICAL NUCLEUS. V.S.Popov.

Zh. eksper. teor. Fiz., Vol.34, No.4, 1021-2 (April, 1958). In Russian. English translation in: Soviet Physics-JETP (New York), Vol.34(7), No.4, 705-6 (Oct., 1958).

A method given by Akhiezer and Sitenko (Abstr 5363 of 1958) for black spherical nuclei is extended to the non-spherical case.

R.J.N.Phillips

539.17

1415 MEASUREMENT OF THE FISSION THRESHOLDS OF Pu^{239}, U^{233}, U^{235}, AND U^{238} USING THE (d,p) REACTION.

J.A.Northrop, R.H.Stokes and K.Boyer.

Phys. Rev., Vol. 115, No. 5, 1277-86 (Sept. 1, 1959).

An experiment is described which measures the fission thresholds of thermally fissionable nuclides. In contrast to fission induced by neutron capture, use of the (d,p) reaction allows compound nuclei to be produced with excitations less than the binding energy of the last neutron. Measurements of the energy spectra of protons in coincidence with fission, normalized by the energy spectra of all emitted protons, have allowed the thresholds of Pu^{239}, U^{233}, and U^{235} to be observed. It should be emphasized that the compound nucleus is stable against neutron emission in the region of these fission thresholds, thus avoiding distortions by this competing reaction. The threshold of U^{238} was also obtained for comparison with neutron data. In the case of the even—even compound nuclei, the observed step structure of the fission threshold is a clear indication of a multiple fission barrier. This multiple barrier is predicted by the collective model of fission and is correlated with the experimental data. The equivalent neutron energies at the centre of the first threshold are as follows: for Pu^{239}, −1.61 MeV; for U^{233}, −1.47 MeV; and for U^{235}, −0.60 MeV. The second thresholds are observable only for the first two: for Pu^{239}, −0.72 MeV, and for U^{233}, −0.72 MeV. The thresholds of U^{238} agrees well with the data from neutron excitation. In each case the fission probability decreases in the region of positive neutron energies. This would result either if neutron were to compete with fission or if there were a significant contribution to the proton spectrum from the electric breakup of the deuteron.

539.17

1416 ANGULAR DISTRIBUTIONS OF PROTONS FROM THE (d,p) REACTION WITH DEUTERON ENERGIES BELOW THE COULOMB BARRIER. J.P.Schiffer and L.L.Lee, Jr.

Phys. Rev., Vol. 115, No. 6, 1705-6 (Sept. 15, 1959).

Cross-sections and angular distributions for the (d,p) reaction to a known $l = 1$ single-particle state of the captured neutron were measured for seven target nuclides between Ti and Ni. Targets with effective thicknesses of several hundred keV were used with deuteron bombarding energies of 3.8 and 4.5 MeV. The angular distributions were found to be similar, with approximately 2 : 1 forward peaking and a broad maximum at about 60°. In addition, a sharp but relatively weak peak was observed at about 25° for the lighter of the target nuclides. This is the angle at which the theory of Butler (Abstr. 8973 of 1951) would predict a maximum for neutron capture with $l_n = 1$. Analysis of the proton spectra and angular distributions indicates that compound nucleus formation contributes less than 25% to the reaction yield at these deuteron energies.

539.17 : 539.11

MATHEMATICAL ANALYSIS OF A SIMPLE METHOD RELATED TO THE STRIPPING REACTION. See Abstr. 1255

539.17 : 539.14

B^{12} POLARIZATION IN B^{11}(d,p)B^{12} REACTION. See Abstr. 1360

539.17

1417 ON THE ANGULAR DISTRIBUTION OF (d,p) STRIPPING REACTIONS. T.Honda and M.Nagasaki.

Proc. Phys. Soc., Vol. 74, Pt 5, 517-28 (Nov., 1959).

It is numerically investigated how the angular distributions of some typical (d,p) stripping reactions given by the Butler theory (Abstr. 8973 of 1951) are modified by the supposition that in a simple (d,p) stripping process protons do not penetrate into the nucleus, in contrast to the assumption of the Butler theory that protons move freely even in the nucleus. The result of the calculation shows that the general trend of the angular distributions given by the present model gives a better fit to the experimental data than that given by the Butler theory, though it is not greatly altered in both relative and absolute values in the cases of relatively light nuclei and high incident energies. The best fit nuclear radii determined by the present model are found to be given by the Gamow—Critchfield formula $a = (1.22A^{1/3} + 1.70) \times 10^{-13}$ cm. These nuclear radii are smaller than some of the best fit nuclear radii obtained in the analyses hitherto done by using the Butler theory.

539.17

1418 ANGULAR DISTRIBUTIONS FROM STRIPPING REACTIONS OF LOW Q VALUES. J.P.F.Sellschop.

Phys. Rev. Letters, Vol. 3, No. 7, 346-8 (Oct. 1, 1959).

Angular distributions of protons from the reactions Li^7(d,p)Li^8, and C^{12}(d,p)C^{13*} (3.09 MeV state) were studied at incident energies of about 1-2 MeV. They were compared with a simple stripping theory, which did not take into account the Coulomb and nuclear interactions. Striking agreement was found and the connection between this fact and the low incident energies and Q values discussed.

J.A.Evans

539.17

1419 OPTICAL-MODEL ANALYSIS OF EXCITATION FUNCTION DATA AND THEORETICAL REACTION CROSS SECTIONS FOR ALPHA PARTICLES. G.Igo.

Phys. Rev., Vol. 115, No. 6, 1665-74 (Sept. 15, 1959).

The complex α-particle—nuclear potential is determined with small uncertainty at the nuclear surface by experiments with α-particles in the range of bombarding energies up to 50 MeV in conjunction with this optical-model analysis which assumed that the shape of the complex potential is exponential at the nuclear surface. The potential is given by the expression

$$V_\alpha + W_\alpha = \left\{ -1100 \exp\left[-\left(\frac{r - 1.17A^{\frac{1}{3}}}{0.574} \right) \right] - 45.7i \exp\left[-\left(\frac{r - 1.40A^{\frac{1}{3}}}{0.578} \right) \right] \right\} \text{MeV},$$

for values of r (in units of 10^{-13} cm) where the real part is $> \sim -10$ MeV. The elastic scattering data was used to determine the potential. The calculated reaction cross-sections are found to be in satisfactory agreement with excitation function data. The total reaction cross-section σ_R for α-particles in the energy range 0-50 MeV on nuclei with charge Z = 10, 20, 30, 50, 70, and 90 was calculated using the potential $V_\alpha + iW_\alpha$ obtained from the analysis of elastic scattering data. The calculated values may be interpolated to obtain σ_R for other values of Z.

539.17

1420 PRODUCTION OF Be^7 IN 30-42 MeV He-ION BOMBARDMENT OF OXYGEN, ALUMINUM AND COPPER. G.H.Bouchard, Jr and A.W.Fairhall.

Phys. Rev., Vol. 116, No. 1, 160-3 (Oct. 1, 1959).

The process was studied using radiochemical techniques. At 40 MeV He-ion bombarding energy the formation cross-sections are 2.4, 0.22 and 0.018 mb, respectively. For aluminium and oxygen targets the Be^7 fragments are emitted sharply forward, implying a direct-interaction mechanism. Estimations of the energies of the Be^7 fragments, along with the observation that for Al^{27} target the yield of Na^{24} is equal to the yield of Be^7, suggests that in this particular case interaction involves the pick-up of a He^3 fragment from the nucleus by the impinging He^4 ion with the deposition of less than 7 MeV of excitation energy in the Na^{24} residual nucleus.

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1421 REACTIONS OF ALPHA PARTICLES WITH GERMANIUM-70 AND ZINC-70. S.Amiel.

Phys. Rev., Vol. 116, No. 2, 415-17 (Oct. 15, 1959).

The reactions $Ge^{70}(\alpha,2n)Se^{72}$, $Ge^{70}(\alpha,pn)As^{72}$, $Zn^{70}(\alpha,pn)Ga^{72}$, and $Zn^{70}(\alpha,2p)Zn^{72}$ were studied with alpha particles of 20-40 MeV, and their excitation functions were measured. The results are compared with evaporation calculations based on the assumption of compound-nucleus formation.

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1422 THE SCATTERING OF ALPHA PARTICLES BY HELIUM. A.C.Butcher and J.M.McNamee.

Proc. Phys. Soc., Vol. 74, Pt 5, 529-39 (Nov., 1959).

Nuclear phase shifts are calculated for the scattering of two alpha particles, using the method of the resonating group structure, and assuming central Gaussian internucleonic potentials and

Gaussian wave functions. It is found that a mixture of two-thirds Serber and one-third M.H.W.B. exchange force gives good agreement with the experimentally observed phase shifts.

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1423 ELASTIC SCATTERING OF N^{14} BY Be^9.

M.L.Halbert and A.Zucker.

Phys. Rev., Vol. 115, No. 6, 1635-42 (Sept. 15, 1959).

Nitrogen—beryllium elastic scattering was measured over an angular range from 32° to 144° in the centre-of-mass system with an angular resolution of about 1°. The mean energy of the incident nitrogen ions was 27.3 MeV. To distinguish elastic scattering from other events, both the scattered and the recoil particles were detected in coincidence by thin CsI(Tl) scintillation counters. The elastic scattering differential cross-section is 550 mb/sterad at 32 deg c.m. It decreases monotonically and more rapidly than $\csc^4(\theta/2)$ to a shallow minimum of about 5 mb/sterad at 106° c.m., rises slightly, and then falls to about 2.5 mb/sterad at 144° c.m., the largest angle measured. The data are compared to the predictions of a sharp-cut-off model for elastic scattering, but no agreement is found between this theory and the experimental results.

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1424 CROSS SECTION FOR COMPOUND-NUCLEUS FORMATION IN HEAVY-ION-INDUCED REACTIONS.

T.D.Thomas.

Phys. Rev., Vol. 116, No. 3, 703-12 (Nov. 1, 1959).

Compound-nucleus-formation cross-sections for various systems of heavy ions and targets were calculated by using two simple models. The first model, based on a square-well nuclear potential, gives reasonable agreement with experiment if a radius parameter $r_0 \cong 1.5 \times 10^{-13}$ is used. The second model, based on a diffuse nuclear potential, gives agreement if $r_0 = 1.17 \times 10^{-13}$ cm is used. The cross-sections calculated by using the first model are presented for various energies of the systems carbon, nitrogen, oxygen, and neon incident on aluminium, potassium, copper, silver, praseodymium, gold, and uranium. Also tabulated are the average values of the orbital angular momentum for each system at each energy.

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1425 INELASTIC SCATTERING OF 500 MeV ELECTRONS FROM Li^6 AND Li^7.

U.Meyer-Berkhout.

Phys. Rev., Vol. 115, No. 5, 1300-3 (Sept. 1, 1959).

500 MeV electrons were scattered from enriched Li^6 and ordinary Li (92.5% Li^7) between scattering angles of 60° and 135° in the laboratory system. The cross-section integrated over the inelastic continuum at these large momentum transfers was compared with the free-proton cross-section at the corresponding angles. The results when compared with those obtained for other light nuclei may be used to yield some insight as to the extent to which the scattering from the individual nucleons can be considered as incoherent.

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1426 NUCLEON CORRELATION EFFECTS IN HIGH-ENERGY ELECTRON SCATTERING.

W.E.Drummond.

Phys. Rev., Vol. 116, No. 1, 183-93 (Oct. 1, 1959).

By using Schiff's high-energy approximation (Abstr. 6364 of 1956), a sum rule is developed which relates the scattering of high-energy electrons from heavy nuclei to the two-particle correlation function for the nucleus. It is shown that correlations due to the Pauli principle give a large effect in the region of momentum transfer from 100 to 300 MeV/c, and that correlations with a range of less than 10^{-13} cm do not make appreciable contribution.

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1427 EFFECT OF NUCLEAR FORCES ON THE CROSS SECTIONS OF PHOTONUCLEAR REACTIONS.

K.Okamoto.

Phys. Rev., Vol. 116, No. 2, 428-36 (Oct. 15, 1959).

The effect of nuclear forces, or the effect of the quasi-deuteron model, is discussed for the integrated cross-section and the bremsstrahlung weighted cross-section. The nuclear force is assumed to be of partly Majorana exchange character. Only the central force is considered. The two-body potential is a Gaussian type without a hard core, the parameters of which are taken from the effective range theory. The calculations are performed by first-order perturbation theory and the results are that the integrated cross-section is increased by about 10% and the bremsstrahlung weighted cross-section is decreased by a few percent. Therefore the independent-particle model can be regarded as a good approximation for photonuclear reactions.

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1428 CONFIGURATIONAL ASSIGNMENTS OF GIANT PHOTONUCLEAR RESONANCES.

D.H.Wilkinson.

Phys. Rev. Letters, Vol. 3, No. 8, 388-9 (Oct. 15, 1959).

The underlying arguments of the I.P.M. of the photoeffect, which attributes the giant resonance to "one quantum" excitations of single particles, are outlined. In view of the recent (d,p) gross structure results of Cohen et al., the author suggests that the high excitation of the dipole-state may be the effect of coherent superposition of particle-hole states, as has been discussed by Brown and Bolsterli (see following abstract). J.A.Evans

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1429 DIPOLE STATE IN NUCLEI.

G.E.Brown and M.Bolsterli.

Phys. Rev. Letters, Vol. 3, No. 10, 472-6 (Nov. 15, 1959).

To explain the nuclear giant dipole resonance, a particle-hole interaction is introduced as a perturbation on the numerous particle-hole states which can be formed by the dipole photon absorption in a nucleus. The effects of this perturbation are calculated in a simplified model: the nearly degenerate levels are shown to mix in such a way as to raise the energy of the highest (most symmetrical) one and to transfer to it much of the dipole transition strengths of all the other levels. The relation of the simplified model to practical cases is discussed. R.F.Peierls

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1430 PHOTONEUTRONS FROM Al.

G.Cortini, C.Milone, T.Papa and R.Rinzivillo.

Nuovo Cimento, Vol. 14, No. 1, 54-61 (Oct. 1, 1959).

The energy spectra of photoneutrons emitted at 90° from Al under bremsstrahlung of 24 and 30 MeV maximum energy were investigated by means of the recoil protons in photoemulsions. The difference between the two spectra shows that above 24 MeV photon energy the neutrons are emitted mainly by a direct process. This process gives a relevant contribution (> 25%) to the photoneutron yield at 30 MeV.

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1431 CHARGED PHOTOPARTICLES FROM ARGON.

V.Emma, C.Milone, R.Rinzivillo and A.Rubbino.

Nuovo Cimento, Vol. 14, No. 1, 62-73 (Oct. 1, 1959).

The (γ,p) and (γ,α) reactions in argon were studied by irradiation of an A gas target with the bremsstrahlung beam of a 31 MeV betatron. Three different maximum bremsstrahlung energies were used: 23, 26 and 30 MeV. The charged photoparticles emitted at an angle around 90° with the γ-ray beam were recorded by nuclear emulsion. Tracks with a total range $< 75\ \mu$m of emulsion are attributed mainly to $A(\gamma,\alpha)$ process whose $d\sigma/d\Omega$ is given. Thus the apparent anomaly disappears in the spectrum $A(\gamma,p)$ with a high and narrow peak at energy lower then the Coulomb barrier. The (γ,p) yield appears to be lower than that found by Spicer (Abstr. 8250 of 1955) and the Canadian workers (Abstr. 10504 of 1954), while seeming to be in agreement with recent results on the $A(\gamma,p)$ cross-section. Hence the $A(\gamma,p)$ cross-section does not seem so abnormally high in respect to other nuclei as it has been accepted to this date.

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1432 $(\gamma,2n)$ REACTIONS IN LIGHT ELEMENTS.

J.O'Connell, P.Dyal and J.Goldemberg.

Phys. Rev., Vol. 116, No. 1, 173-4 (Oct. 1, 1959).

The yields at several energies for the reactions $C^{12}(\gamma,2n)C^{10}$, $O^{16}(\gamma,2n)O^{14}$, $F^{19}(\gamma,2n)F^{17}$, $Na^{23}(\gamma,2n)Na^{21}$, $P^{31}(\gamma,2p)Al^{29}$, and $P^{31}(\gamma,2pn)Al^{28}$ were measured using the X-ray beam from the University of Illinois 300 MeV betatron. It was found that the ratio of integrated cross-sections of the $(\gamma,2n)$ to (γ,n) reactions in F^{19} and in Na^{23} is of the order of 0.1 and approximately 1-2 orders of magnitude smaller for C^{12} and O^{16}. The small $(\gamma,2n)$ yields for C^{12} and O^{16} are consistent with statistical competition between emitted particles if the gamma-ray absorption decreases rapidly with energy above the giant resonance.

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1433 GAMMA RAYS FROM THE NUCLEAR PHOTOEFFECT IN CARBON, OXYGEN, AND COPPER.

A.S.Penfold and E.L.Garwin.

Phys. Rev., Vol. 116, No. 1, 120-30 (Oct. 1, 1959).

A NaI crystal was used to study the spectra of gamma rays associated with the giant resonance cross-section of the nuclear photoeffect in carbon, oxygen, and copper. The X-ray source was a bremsstrahlung beam whose energy was varied from 19 to 61 MeV. Cross-sections for elastic, and mixed elastic and inelastic scattering were measured at 135° to the X-ray beam. The copper cross-section has a magnitude which is well predicted by particle photoproduction cross-sections coupled with a dipole dispersion theory. The elastic scattering cross-section for carbon can be predicted in a similar fashion, but the oxygen cross-section cannot. For oxygen, the observed cross-section is much larger than the predicted one and this result is explained if narrow, isolated, resonances are an important part of the oxygen photonuclear cross-section. The different behaviour of carbon and oxygen which is found is consistent with other experiments. The angular dependence of the oxygen elastic scattering cross-section near 22 MeV is predominantly dipole with a possible quadrupole admixture. For oxygen, an inelastic scattering cross-section was observed which has a threshold at about 26 MeV, a peak at about 30 MeV, and is due to transitions to a state (or states) near 6 MeV. It is interpreted as the result of an overlap of two giant resonance cross-sections—one for the ground state and one for the excited state. The consequences of this interpretation to the theory of the nuclear photoeffect is discussed. The yield of gamma rays from O^{15} and N^{15} which follow neutron or proton emission was also studied and several lines were observed, but none above 6.5 MeV. The photonuclear cross-sections associated with these lines are estimated to be 45% of the whole photonuclear cross-section at 23 MeV.

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1434 CAPTURE GAMMA RAYS FROM O^{15} AND O^{16} IN THE REGION OF THE GIANT RESONANCE.

S.G.Cohen, P.S.Fisher and E.K.Warburton.

Phys. Rev. Letters, Vol. 3, No. 9, 433-4 (Nov. 1, 1959).

The 90° yield of ground state γ-rays in the reaction $N^{15}(p,\gamma)O^{16}$ was measured by bombarding a thin-windowed cell containing 98.7% pure N^{15} by the external proton beam of the Princeton FM cyclotron reduced in energy by polythene absorbers to cover the range 9-15 MeV. Broad resonances were observed with maxima at 21.8 and 24.7 MeV excitation in O^{16}, there being good evidence for detailed structure in the upper one. These are in excellent agreement with the calculations of Elliott and Flowers (Abstr. 717 of 1958) who predict $J^{\pi} = 1^-$, T = 1 levels at 22.6 and 25.2 MeV arising from $p^{-1}d$ and $p^{-1}2s$ configurations in O^{16}, which are assumed to be responsible for the electric dipole giant resonance absorption from the ground state of O^{16} in the inverse process. Results for the ratio of the γ widths of the two resonances are also in fair agreement with the calculations. The reaction $N^{14}(p,\gamma)O^{15}$ was also studied, using a melamine target. The 90° yield of ground state radiation was in this case constant with excitation energy over the range 19-25 MeV and no sharp resonance at about 20.5 MeV was seen. This had previously been reported in the reaction $N^{15}(\gamma,p)C^{14}$ where N^{15} is the mirror nucleus of O^{15}. If, however, it had T = 3/2, the corresponding level in O^{15} would not be excited in the reaction N^{14} + p. R.E.Meads

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1435 FINE STRUCTURE IN THE $O^{16}(\gamma,n)O^{15}$ YIELD CURVE.

H.King and L.Katz.

Canad. J. Phys., Vol. 37, No. 12, 1357-64 (Dec., 1959).

Fine structure in the $O^{16}(\gamma,n)O^{15}$ yield near threshold was examined using improved experimental techniques. Breaks were observed at threshold, 15.85, 16.14, 16.45, 16.74, 16.88, 17.05, 17.15, and 17.21 MeV. These energies are established to within ±0.04 MeV. The integrated photon absorption cross-section in these breaks resulting in (γ,n) reactions was found to be 0.47 ± 0.11 MeV-mb. The results are in good agreement with the measurements of other workers.

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1436 THE PHOTODISINTEGRATION OF MANGANESE AND RHODIUM.

R.W.Parsons.

Canad. J. Phys., Vol. 37, No. 12, 1344-8 (Dec., 1959).

The cross section for the production of photoneutrons from Mn^{55} and Rh^{103} has been found by irradiating these elements in the X-ray beam of a 24 MeV betatron For Mn^{55}, the giant resonance shows two distinct peaks and the intrinsic quadrupole moment is estimated to be 0.73 ± 0.14 barn; for Rh^{103}, two peaks cannot be resolved, but the shape of the giant resonance curve is consistent with an intrinsic quadrupole moment of approximately 2.1 barns

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1437 EXCITATION FUNCTION FOR THE $V^{51}(\gamma,\alpha)Sc^{47}$ REACTION.

P.Dyal and J.P.Hummel.

Phys. Rev., Vol.115, No.5, 1264-8 (Sept.1, 1959).

Yields of the $V^{51}(\gamma,\alpha)Sc^{47}$ reaction were determined by measuring the Sc^{47} radioactivity produced in metallic vanadium targets irradiated with bremsstrahlung and maximum energy varying from 10.5 to 25 MeV. The reaction was not observed below 15.5 MeV because of the severe effect of the Coulomb barrier on the outgoing alpha particles. The excitation function derived from these measurements has a maximum value of 0.81 mb at 23 MeV, and the integrated cross-section to 24.5 MeV is 4.3 MeV-mb. The observed excitation function agrees very well with one calculated from a statistical theory for the decay of a compound nucleus. This appears to be a general feature of (γ,α) reactions in medium-weight nuclei.

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1438 TOTAL CROSS-SECTION MEASUREMENTS FOR NEUTRONS BETWEEN 2.1 AND 3.1 MeV.

G.Deconninck and A.Martegani.

Bull. Acad. Roy. Belgique Cl. Sci., Vol. 4, No. 10, 851-62 (1958).

In French.

The total neutron cross-sections of lead, bismuth, magnesium, calcium and copper were measured as a function of energy between 2.1 and 3.1 MeV, after applying a diffusion correction. The neutrons were produced by the $D(d,n)He^3$ reaction and energy selected by varying the angle of observation with respect to the incident beam. Resonances were observed at 2.35 and 2.65 MeV for magnesium and at about the same energies for calcium.

A.E.I. Research Laboratory

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1439 STRUCTURES IN THE PROTON SPECTRA FROM n,p REACTIONS.

L.Colli, F.Cvelbar, S.Micheletti and M.Pignanelli.

Nuovo Cimento, Vol. 14, No. 1, 81-9 (Oct. 1, 1959).

Measurements on proton energy spectra from n,p reactions on Mg, Al, Si and S show the existence of well defined peaks even at excitation energy values where the excitation levels of the residual nucleus are very dense. Comparing results with some proton spectra from d,p reactions a similarity is found in the position of these peaks on the residual excitation energy scale. By means of this comparison it is possible to establish that the n,p reactions go through a mechanism of the type of surface effect, where the residual nucleus is left preferably in some excited states probably corresponding to single particle excitation.

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1440 STUDY OF THE REACTIONS $F^{19}(n,d)O^{18}$ AND $P^{31}(n,d)Si^{30}$ WITH 14.1 MeV NEUTRONS.

G.E.Velyukhov, A.N.Prokof'ev and S.V.Starodubtsev.

Dokl. Akad. Nauk SSSR, Vol. 127, No. 4, 781-3 (Aug. 1, 1959).

In Russian.

A flux of 5 × 10^9 neutrons/sec from the $T(d,n)He^4$ reaction using 260 keV deuterons was measured by detecting the α-particles in a CsI:Tl scintillation counter. Protons and deuterons from the reactions were distinguished by measuring E and dE/dx in a telescope of two proportional and two scintillation counters. 2×10^9 n/cm² were directed on the targets. For transitions to the ground state in the $F^{19}(n,d)O^{18}$ reaction a Q value −5.9 ± 0.3 MeV was measured. Transition rates to excited states of O^{18} at 1.99, 3.50, and 3.98 MeV are too small to be studied. In the $P^{31}(n,d)Si^{30}$ reaction Q was found to be −5.2 ± 0.2 MeV. In each case a good fit to Butler's stripping theory was obtained $l = 0$ and $r_0 = 5 \times 10^{-13}$ cm. Transitions to excited states of Si^{30} at 2.24, 3.51 and 3.79 MeV are being studied. The results agree with previous experiments at Los Alamos. D.W.L.Sprung

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1441 CROSS SECTION FOR THE $Li^6(n,\alpha)H^3$ REACTION FOR $1.2 \leq E_n \leq 8.0$ MeV.

R.B.Murray and H.W.Schmitt.

Phys. Rev., Vol. 115, No. 6, 1707-12 (Sept. 15, 1959).

The cross-section was measured as a function of neutron energy. An essentially back-to-back method was used, with a thin cylindrical $Li^6I(Eu)$ scintillation crystal placed concentric with and adjacent to a thin-walled ionization chamber containing a deposit of fissile material (U^{238} or Np^{237}). The magnitude of $\sigma_{n,\alpha}$ as measured in this experiment depends on the absolute value of $\sigma_{fiss}(U^{238})$, while the shape of the cross-section versus energy curve depends on the known energy dependence of $\sigma_{fiss}(U^{238}$ or $Np^{237})$. Statistical and other point-to-point uncertainties in the data range from ±5 to ±9%, while the uncertainty in absolute value of the cross-section is ±7%. The cross-section obtained from these measurements decreases monotonically from a value of 0.28 barn at E_n = 1.2 MeV to 0.051 barn at E_n = 8.0 MeV.

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1442 (n,d) REACTIONS WITH 14 MeV NEUTRON ENERGY.

L.Colli, F.Cvelbar, S.Micheletti and M.Pignanelli.

Nuovo Cimento, Vol.13, No.4, 868-70 (Aug. 16, 1959).

The cross-section and spectrum for the (n,d) reaction with deuterons emitted at forward angles are presented for P^{31} and S^{32}. The most intense deuteron line, in each case, corresponds to the ground state of the residual nucleus showing that the n-d reaction proceeds by a mechanism of the direct type. The results can be predicted by a pick-up reaction and are in excellent agreement with the angular momentum of the last proton in each nucleus predicted by the shell model (i.e. s-state proton, l = 0 transition). J.D.Dowell

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1443 DISTRIBUTION CORRELATIONS IN Sb(n,p)Sn.

R.A.Peck, Jr., H.P.Eubank and R.M.Howard.

Nuovo Cimento, Vol. 14, No. 2, 397-402 (Oct. 16, 1959).

This reaction was studied at 14 MeV neutron energy and over the ranges 0 to 3 MeV excitation and 0 to 60°. It is demonstrated that the forward-peaked contribution is relatively concentrated at high proton energy and gives rise to most of the spectral group structure, and that the angle-insensitive portion has a smooth spectrum rising with decreasing proton energy. The isotropic portion does not fit the theoretical compound nucleus spectrum but is consistent with a process of incomplete compound nucleus formation. Total cross-section for the ranges of energy and angle studied is (22 ± 4) mb, of which 20% is the anisotropic contribution.

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1444 TOTAL NEUTRON CROSS SECTION OF Xe^{135} AS A FUNCTION OF ENERGY.

E.C.Smith, G.S.Pawlicki, P.E.F.Thurlow, G.W.Parker, W.J.Martin, G.E.Creek, P.M.Lantz and S.Bernstein.

Phys. Rev., Vol. 115, No. 6, 1693-9 (Sept. 15, 1959).

The total neutron cross-section of Xe^{135} as a function of energy was remeasured at Oak Ridge National Laboratory under more favourable conditions than obtained in earlier measurements (Bernstein et al., Abstr. 4652 of 1956). A sample thickness of 2.5×10^{18} atoms of Xe^{135} gas per cm^2 was procured from the gases generated in a homogeneous reactor. A mechanical time-of-flight chopper was used to select neutrons in the energy range from 0.01 eV to several thousand eV. The number of Xe^{135} atoms in the sample was determined by means of mass spectrometer measurements on the long-lived daughter, Cs^{135}. The data of the low-energy resonance were fitted to the single-level Breit—Wigner formula, taking into account Doppler corrections, equally well with the following two sets of parameters: statistical weight factor $g = \frac{3}{8}$; resonance energy $\epsilon_0 = 0.08472 \pm 0.00027$ eV; neutron width at energy ϵ_0, $\Gamma_n{}^0 = 0.03477 \pm 0.00021$ eV; capture width $\Gamma_a = 0.083303 \pm 0.00062$ eV; for $g = \frac{5}{8}$, $\epsilon_0 = 0.08415 \pm 0.00028$ eV; $\Gamma_n{}^0 = 0.02057 \pm 0.00012$ eV; $\Gamma_a = 0.09493 \pm 0.00017$ eV. The errors quoted are the standard deviations from the statistics of the measurements. Systematic errors are discussed. No evidence for resonances at energies greater than 0.085 eV was observed. The results described are interpreted in terms of recent considerations on the statistics of the properties of nuclear energy levels.

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1445 SIMPLE MODEL FOR GIANT RESONANCE EFFECTS IN NUCLEAR REACTIONS.

W.Tobocman and D.E.Bilhorn.

Phys. Rev., Vol.115, No.5, 1275-7 (Sept. 1, 1959).

A simple model for the scattering of s-wave neutrons is discussed. The scattering interaction is a square-well potential modified by allowing transmission through the origin to a mode of motion characterized by many narrow resonances. When the coupling out of the incident channel is weak, the cross-section is found to have a resonant part which shows the giant resonance behaviour observed in nuclear scattering.

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1446 CROSS SECTIONS FOR SOME (n,pn) REACTIONS WITH HEAVY NUCLIDES.

J.F.Barry, R.F.Coleman, B.E.Hawker and J.L.Perkin.

Proc. Phys. Soc., Vol. 74, Pt 5, 632-8 (Nov., 1959).

The (n,pn) cross-sections of five heavy nuclides for 14.5 MeV neutrons were measured using activation methods. The variation of both the (n,pn) and (n,p) cross-sections of W^{186} with neutron energy in the range 13 to 22 MeV was also investigated. All the cross-sections found have been compared with those calculated using the direct interaction theory of Brown and Muirhead (Abstr. 5619 of 1957).

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1447 μ-MESON CAPTURE IN Li^6 LEADING TO THE GROUND STATE OF He^6.

H.Überall.

Phys. Rev., Vol.116, No.1, 218-26 (Oct. 1, 1959).

Presents calculations of the rate of the capture reaction of μ-mesons in Li^6 leading to the He^6 ground state (Godfrey-type reaction), a process which is expected to give more accurate information on the μ-capture coupling constants than the capture in nuclei leading to all possible final states. Induced pseudoscalar coupling and Gell-Mann's conserved vector current are taken into account, and numerical results are given assuming a universal weak interaction. The Li^6 and He^6 wave-functions are taken as shell model states with LS coupling and configuration mixing. It is found that the capture rate is sensitive to the p-shell radius, and for a determination of the latter, the Stanford electron scattering results for Li^6 have been analysed taking into account the recoil motion of the α-particle core; however, the main portion of the radial integral in the theoretical capture rate can be read off the scattering data directly. The capture rate is found to be of order of 0.4×10^3 sec^{-1}, its exact value still depending on some assumption about the coupling.

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1448 RADIOCHEMICAL STUDIES OF THE FISSION OF U^{235} INDUCED BY HELIUM IONS.

R.Gunnink and J.W.Cobble.

Phys. Rev., Vol. 115, No. 5, 1247-56 (Sept. 1, 1959).

The absolute fission yields of approximately 25 nuclides were determined with an accuracy of ± 5-15% for several energies ranging from 20 to 40 MeV. Such features of fission as the symmetric—asymmetric modes of fission, the relation of total fission cross-section to compound nucleus theory, fine structure in fission product distribution, valley-to-peak ratios, and neutron emission are discussed as well as some of the experimental details involved.

539.17

1449 DIRECT-INTERACTION EFFECTS IN MEDIUM-ENERGY FISSION OF URANIUM.

W.J.Nicholson and I.Halpern.

Phys. Rev., Vol. 116, No. 1, 175-7 (Oct. 1, 1959).

The fraction of the fission events which occur after direct interactions rather than after compound nucleus formation was determined in a number of bombardments of uranium. The projectiles used were 10.5 MeV protons, 21 MeV deuterons, and 42 MeV α-particles. The fraction of post-direct-interaction fissions was obtained from measurements of the angular correlation of coincident pairs of fission fragments which emerged at approximately 90° to the incident particle beam. The results indicate that (2 ±3)% of fission events in 42 MeV α-particle bombardments and (5±5)% in 21 MeV deuteron bombardments follow some type of direct interaction.

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1450 SPALLATION—FISSION COMPETITION IN HEAVY-ELEMENT REACTIONS: $Th^{232} + He^4$ AND U^{233} + d.

B.M.Foreman, Jr., W.M.Gibson, R.A.Glass and G.T.Seaborg.

Phys. Rev., Vol. 116, No. 2, 382-92 (Oct. 15, 1959).

Cross-sections and excitation functions were determined for spallation and fission products from bombardments of Th^{232} with helium ions (15 to 46 MeV) and U^{233} with deuterons (9 to 24 MeV). This work extends a series of investigations of charged particle (α,d, and p) induced reactions in heavy elements ($Z \geq 88$). Radiochemical methods were employed to isolate products corresponding to the following spallation reaction: neutron emission, (α,4n), (α,5n), (d,n), (d,2n), and (d,3n); emission of one proton and neutrons (α,p), (α,pn), (α,p2n), and (α,p3n); and emission of two protons and neutrons, (α,2p), (α,2pn), and (α,αn), and (d,αn). In addition, the following fission products were isolated from one or more bombardments: Zn^{72}, Ge^{77}, As^{77}, $Br^{82,83}$, Rb^{86}, $Sr^{89,91}$, Y^{93}, $Zr^{95,97}$, Nb^{96}, Mo^{99}, $Ru^{103,105,106}$, $Pd^{109,112}$, Ag^{111}, $Cd^{115,115m,117}$, $I^{131,133}$, Cs^{136}, $Ba^{139,140}$, La^{140}, $Ce^{141,143,144}$, Nd^{147}, Eu^{157}, and Gd^{159}. The results show that fission is the predominant reaction at all energies for Th^{232} and to an even greater extent for U^{233}. The data for the surviving spallation products are consistent with several mechanisms of reaction, including compound-nucleus formation and evaporation, direct interactions between nucleons of the incoming helium ion or deuteron and nucleons of the nucleus, and a combination of these types of processes (direct interaction followed by evaporation). In general, the results confirm and extend previously established concepts. The neutron-emission spallation reactions as well as fission are best explained as proceeding through compound-nucleus formation. The shapes and magnitudes of $(\alpha,4n)$, $(d,2n)$, and $(d,3n)$ excitation functions correlate well with a compound-nucleus treatment modified to include fission competition. According to this treatment, ratios of neutron to total-reaction level width, $\Gamma_n/\Sigma_i\Gamma_i$, are 0.49 for $U^{236-233}$ [from $Th^{232}(\alpha,4n)$], 0.17 for $Np^{235-234}$ [from $U^{233}(d,2n)$], and 0.20 for $Np^{235-233}$ [from $U^{233}(d,3n)$]. In addition the total-reaction excitation functions (consisting mostly of the fission excitation functions) are consistent with theoretical cross-sections for compound-nucleus formation calculated with a nuclear radius parameter $r_0 = 1.5 \times 10^{-13} A^{\frac{1}{3}}$. The fission mass-yield curves are similar to those found for other heavy target isotopes (for elements from thorium to plutonium). The minimum in the curves in the region of mass 120 tends to disappear as helium-ion or deuteron energy is increased. The (α,pxn), $(\alpha,2pxn)$, $(\alpha,\alpha n)$, (d,n), and $(d,\alpha n)$ products are attributed to direct interactions, with complex particles emitted in preference to a series of protons and neutrons. Thus (α,d), (α,t), and (α,tn) mechanisms would account for most of the (α,pn), $(\alpha,p2n)$, and $(\alpha,p3n)$ products, respectively. In the case of the (α,t) and (α,tn) reactions, analysis of the ratio $\sigma(\alpha,tn)/\sigma(\alpha,t)$ leads one to the conclusion that with 35 MeV helium ions only 9% of outgoing tritons leave the residual nucleus with sufficient energy to evaporate a neutron or undergo fission, and with 44 MeV helium ions only 20% do so. The (d,n) product probably results from the stripping reaction.

539.17

1451 THE ANGULAR DISTRIBUTION OF PHOTOFISSION FRAGMENTS.

A.P.Baerg, R.M.Bartholomew, F.Brown, L.Katz and S.B.Kowalski.

APPENDIX: CALCULATION OF ANGULAR RESOLUTION CORRECTIONS.

P.M.Dyson, J.M.Kennedy and E.Vogt.

Canad. J. Phys., Vol. 37, No. 12, 1418-35, 1435-7 (Dec., 1959).

Angular distributions of photofission fragments relative to the photon beam have been measured as a function of maximum bremsstrahlung energy in the range 6-20 MeV. The nuclides U^{233}, U^{235}, Np^{237}, Pu^{239} and Am^{241} give an isotropic distribution at all energies studied. The nuclides Th^{232}, U^{234}, U^{236}, U^{238} and Pu^{240} give anisotropic distributions which can be described by an equation of the form $W(\theta) = 1 + \alpha \sin^2 \theta$ where θ is the angle between fragment and beam. The degree of anisotropy is large at low energy and falls rapidly as the energy is increased. At a given energy Th^{232} has the greatest degree of anisotropy and Pu^{240} the least.

539.17

1452 EFFECTIVE CROSS-SECTIONS AND ANISOTROPY OF THE FISSION OF Np^{237} AND Th^{230}.

B.M.Gokhberg, G.A.Otroshchenko and V.A.Shigin.

Dokl. Akad. Nauk SSSR, Vol. 128, No. 6, 1157-9 (Oct. 21, 1959).

In Russian.

Measurements of the total cross-section and anisotropy of the fission of Np^{237} and Th^{230} by neutrons with energies up to 1500 keV are described. It is found that for Np^{237} the cross-section remains at about 20 mb between 12 and 100 keV, and then rises steeply. The anisotropy is measured above 350 keV, and appears to be small. For Th^{230}, the fission threshold is at 650 keV. The cross-section rises to a local maximum close to this, and then rises steeply after the minimum. The anisotropy changes gradually in this region. These results are compared with the predictions of the collective model.

D.J.Thouless

539.17

1453 NEUTRON THERMALIZATION: SPACE–ENERGY DISTRIBUTION IN HEAVY MEDIA WITH CONSTANT CROSS-SECTIONS.

J.Virkkunen.

Ann. Acad. Sci. Fennicae A VI, No. 33, 11 pp. (1959).

The basic equations for the neutron density in an infinite, homogeneous, heavy moderator with energy independent neutron absorbtion and scattering cross-sections are worked out neglecting chemical bonding in a manner similar to Kazarnovsky et al. (Geneva Conference, 1958). The solutions for small energies and for large distances from the neutron source are described. Further, more involved cases are worked out: an asymptotic solution for high energies (similar to Fermi age equation); a more general solution by Green's functions in terms of Laguerre polynomials with particular cases of a point source and a source with a Maxwell spectrum.

D.H.Lord

539.17

1454 NUMBER OF PROMPT NEUTRONS EMITTED PER THORIUM-232 FISSION.

A.B.Smith, R.G.Nobles and S.A.Cox.

Phys. Rev., Vol.115, No.5, 1242-3 (Sept. 1, 1959).

The number of prompt neutrons emitted per Th^{232} fission is compared to the number emitted per U^{238} fission. At a bombarding neutron energy of 1.4 MeV the ratio for Th^{232} to U^{238} is 0.98 ± 0.08.

539.17

1455 NEUTRON FISSION CROSS SECTIONS OF Pu^{236} AND Pu^{237}.

J.E.Gindler, J.Gray, Jr and J.R.Huizenga.

Phys. Rev., Vol.115, No.5, 1271-4 (Sept. 1, 1959).

The thermal-neutron fission cross-sections were determined by counting samples placed in the thermal column of the Argonne heterogeneous heavy-water reactor, CP-5. Comparison of the fission counting rate of the Pu^{236} and Pu^{237} samples with that of Pu^{239} standard gave cross-sections of 170 ± 35 and 2500 ± 500 barns, respectively, for the two nuclides. The K-to-total electron capture branching ratio for Pu^{237} was found to be 0.38 ± 0.06.

539.17

1456 ANGULAR DISTRIBUTIONS OF FRAGMENTS FROM NEUTRON-INDUCED FISSION OF U^{233} AND Pu^{239}.

L.Blumberg and R.B.Leachman.

Phys. Rev., Vol. 116, No. 1, 102-6 (Oct. 1, 1959).

Angular distributions of fragment activities were measured and show in detail the energy dependence of these distributions. The theoretically expected difference in low-energy anisotropy for these nuclides, which have similar fission thresholds but significantly different target spins, was not observed. A statistical model of fission anisotropy is applied to the data from the low-spin target Pu^{239} to determine the energy dependence of K_0, the standard deviation of the distribution in the angular-momentum projection on the nuclear symmetry axis. The anisotropies indicate an increase of K_0 with energy in excess of the fission barrier, with K_0 values for even–even fissioning nuclei at excitation energies approximately 1 MeV higher than those for odd-A nuclei. The effective moment of inertia about the symmetry axis, similarly obtained from application of a statistical model to the data, is found to be ~0.1 that of a rigid spherical nucleus. (See also following abstract).

539.17

1457 ENERGY DEPENDENCE OF FISSION FRAGMENT ANISOTROPY.

J.J.Griffin.

Phys. Rev., Vol. 116, No. 1, 107-118 (Oct. 1, 1959).

The dependence on energy of the anisotropy of fission fragment emission is discussed in terms of the Bohr model. It is shown that reasonable assumptions about the spectrum of excited states at the barrier lead to results consistent with the currently available data for energies up to 10 MeV and for a variety of target nuclides, except for the fact that the target spin appears to have a much smaller effect on the anisotropy than might have been predicted. It is suggested that this anomaly may be understood in terms of the deformation of the target nucleus.

539.17

1458 THERMONUCLEAR RESEARCH IN GREAT BRITAIN.

R.Latham.

Nature (London), Vol. 184, 1015-20 (Oct. 3, 1959).

Report of a conference on Sept. 17-18, 1959 held by the Physical Society in London. The contributions were largely devoted to outlining the research programmes at the various laboratories, universities and research institutes.

539.17 : 523.87

COMPLETION OF THE PROTON–PROTON REACTION CHAIN AND THE POSSIBILITY OF ENERGETIC NEUTRINO EMISSION BY HOT STARS. See Abstr. 848

539.17 : 523.84

ROLE OF FUSION CHAIN REACTIONS IN THE NONSTATIONARY EVOLUTION OF SUPERNOVA STARS.

See Abstr. 845

539.17

1459 SPONTANEOUS NUCLEAR REACTION IN MOLECULAR HYDROGEN. R.G.Brewer.

Phys. Rev., Vol. 115, No. 5, 1290-2 (Sept. 1, 1959).

The probability that two protons in a hydrogen molecule spontaneously react to form a deuteron is calculated by the use of WKB wave-functions. The complete shape of the molecular barrier is derived from spectroscopic data for the hydrogen molecule and from a perturbation calculation of the helium atom. Use of this potential function shows that the probability of penetrating the molecular barrier (for a ground-state molecule) is greater by a factor of 10^{15} than of penetrating a Coulomb barrier at the same internuclear distance. The half-lives for nuclear reaction in the isotopic molecules H^1H^1, H^1H^2 and H^2H^2 are 1×10^{57}, 1×10^{47} and 2×10^{54} years.

NUCLEAR POWER STUDIES

539.17 : 539.12

MULTILAYER NEUTRON TRANSPORT PROBLEMS.

See Abstr. 1284

539.17 : 536.2

1460 THE TEMPERATURE DISTRIBUTION IN A FINITE UNSHEATHED CYLINDER WITH TIME DEPENDENT DISTRIBUTION OF HEAT SOURCES. APPLICATION TO A VERY LONG FUEL ELEMENT. M.Angelopoulos.

Atomkernenergie, Vol. 4, No. 9, 359-63 (Sept., 1959). In German.

The equation

$$k\left[\frac{\partial^2 T}{\partial r^2} + \frac{1}{r}\frac{\partial T}{\partial r} + \frac{\partial^2 T}{\partial z^2}\right] + Q(r,z,t) = \rho c \frac{\partial T}{\partial t}$$

is considered representing the heat conduction in a finite bare cylinder with time dependent internal heat generation, and the solution is obtained by means of integral transforms. The coolant temperature is assumed to be a function of z but independent of time t. The case of a very long cylinder, representing a very long fuel element, is discussed, and an approximate expression is derived for the temperature distribution. S.Weintroub

539.17

1461 SOME REMARKS ON THE GENERATION OF NUCLEAR POWER BY CONTROLLED FUSION PROCESSES.

A.Szalay and D.Berényi.

Acta phys. Hungar., Vol. 10, No. 1, 39-55 (1959).

Pre-Geneva-conference generalia. See Abstr. 11542 of 1959.

ATOMS

539.18

1462 EXPANSION OF THE HARTREE–FOCK APPROXIMATION BY MEANS OF A CORRELATION FUNCTION.

L.Szász.

Z. Naturforsch., Vol. 14, No. 12, 1014-20 (Dec., 1959). In German.

To take into account the correlation between the valence electrons of an atom with N core electrons and two valence electrons, the trial function suggested by Fock, Wesselow and Petrashen is used:

$$\Psi = \frac{1}{\sqrt{(N+2)!}} A\,\varphi_1(1)\varphi_2(2)\ldots\varphi_N(N)\varphi(N+1, N+2).$$

Here A is the antisymmetrization operator; $\varphi_1, \varphi_2, \ldots, \varphi_N$ are the atomic core one-electron wave-functions; and Φ is the two-electron wave-function of the valence electrons. The system of equations is investigated which will provide the best determination of the functions $\varphi_1, \varphi_2, \ldots, \Phi$. With the aid of the energy minimum principle it is shown that if one neglects the effect of the valence electrons on the atomic core, the core electron functions can be determined from the Hartree–Fock equations $H_F\varphi_i = E_i\varphi_i$, ($H_F$ = Hartree–Fock Hamiltonian operator, $i = 1, 2, \ldots, N$) while the valence electron function satisfies the equation:

$$\left[H_F(1) + H_F(2) + (1 - \Omega(1,2))\,\frac{1}{r_{12}}\right]\Phi = E\,\Phi.$$

The operator $[1 - \Omega(1,2)]$ is a projection operator with the following property: if one expands the function $\Phi(1,2)$ in terms of the functions of the operatio $H_F(1) + H_F(2)$ then the operator $[1 - \Omega(1,2)]$ removes the core functions $\varphi_1, \varphi_2, \ldots, \varphi_N$ from the expansion.

539.18

1463 CHOICE OF THE INITIAL SINGLE-ELECTRON WAVE-FUNCTIONS FOR THE SOLUTION OF SELF-CONSISTENT FIELD EQUATIONS WITH EXCHANGE. T.K.Rebane.

Optika i Spektrosk, Vol. 4, No. 3, 398-400 (1958). In Russian.
English summary: PB 141047T-4 obtainable from Office of Technical Services, U.S. Dept. of Commerce Washington, D.C. U.S.A.

The method of self-consistent field with exchange first given by Fok (Fock) (Abstr. 2448, 3343 of 1930) makes it possible to find the best wave-function for a multielectron system with full separation of the variables of separate electrons. In this method the ground-state wave-function of an n-electron system is given in the form of a determinant consisting of single-electron functions φ_i. Since the wave-function and all the physical properties of an n-electron system are invariant under unitary transformations of the single-electron wave-functions φ_i, one may use orthogonal combinations of the φ_i functions as new single-electron functions ψ_i. The author derives a condition for choice, from all possible orthogonal combinations $\psi_i^{(0)}$ of the initial single-electron functions, of that function which is the best initial approximation to a solution of the self-consistent field equation which involves ψ_i.

539.18 : 539.19

1464 USE OF AN ELECTRONIC COMPUTER FOR THE CONSTRUCTION OF EXACT EIGENFUNCTIONS OF ORBITAL ANGULAR MOMENTUM IN L–S COUPLING.

E.Abate and E.Fabri.

Nuovo Cimento, Vol. 14, No. 1, 29-47 (Oct. 1, 1959).

The application of a digital electronic computer to the evaluation of exact eigenfunctions of total orbital angular momentum for many-electron systems is studied. Some unusual features presented by such problem, as compared with ordinary applications of electronic computers, are discussed. Computations have been carried out following the projection operator technique, and results are given for 3 and 4 electrons in d- and f-states, and for 5 electrons in d-states only. Because of the relative smallness of the computer used, results are not complete; the method followed, however, appears to be quite promising for future extensions of the computation with a bigger machine.

539.18

1465 EVALUATION OF COULOMB REPULSION INTEGRALS FROM SPECTROSCOPIC DATA. R.D.Brown.

Molecular Phys., Vol.1, No.3, 304-6 (July, 1958).

The Coulomb repulsion between two 1s electrons is shown to be 8.002 eV by extrapolation down isoelectronic series and after correction for screening effect. R.W.Nicholls

539.18

1466 ELECTRONIC POLARIZABILITIES OF IONS. R.M.Sternheimer.

Phys. Rev., Vol. 115, No. 5, 1198-206 (Sept. 1, 1959).

For previous work see Abstr. 1131 (1955); 5423 (1958). The dipole polarizability α_d is calculated for several ions by solving the Schrodinger equation for the first-order perturbation of the wave-functions of the core electrons. General results are obtained for the number of nodes of the various types of perturbed wave-functions ($nl \to l'$) in terms of the principal quantum number n. Tables of the perturbed wave-functions for the Na^+ and Cl^- ions are presented. The results for α_d of Na^+, K^+, Rb^+, and Cs^+ are in reasonable agreement with those obtained in previous work. Calculations are also carried out for the electric field at the nucleus due to the charge distribution induced in the ion by an external charge. Values of the quadrupole shielding constant γ_∞ are obtained for several helium-like ions.

539.18

1467 LIFETIME OF THE 2S STATE OF ATOMIC HYDROGEN.

W.L.Fite, R.T.Brackmann, D.G.Hummer and R.F.Stebbings.

Phys. Rev., Vol.116, No.2, 363-7 (Oct., 1959).

A sensitive test for any mixing of the $2S_{1/2}$ and $2P_{1/2}$ state of atomic hydrogen is the measurement of the rate for single-quantum decay of the 2S atom to the ground state. A new upper limit of this decay rate is determined. A section along a beam of 2S atoms, produced by electron excitation of a ground-state atom beam, was viewed by an iodine-vapour-filled ultraviolet photon counter, which responds to the Lymann-alpha radiation of the single-quantum decay process. From the counts observed when an electrostatic quenching field was superposed on the counter's field of view, the necessary experimental parameter (product of 2S atom current and counter efficiency) was determined. With the field removed, a portion of the remaining counts could be ascribed to quenching on collision of the 2S atoms with residual gases in the vacuum chamber, the quenching cross-sections for which were measured. The decay rate not ascribable to known quenching effects was 420 $\sec^{-1}$. Since unknown quenching effects may have been operative, this figure must be considered only as an upper limit for the natural single-quantum decay rate. (See also Abstr. 1475 of 1960).

539.18

1468 APPLICATION OF WAVE FUNCTIONS CONTAINING INTERELECTRON COORDINATES. I. THE GROUND-STATE ENERGY OF LITHIUM.

P.Walsh and S.Borowitz.

Phys. Rev., Vol. 115, No. 5, 1206-15 (Sept. 1, 1959).

Pluvinage (1950) made a substantial advance in the use of interelectron coordinates in atomic systems by illustrating how the Schrödinger equation can be partially separated in such a way that the interelectron potential no longer appears as the perturbing term. His method gave excellent results when used to obtain variational energies of helium-like systems. In this paper, the Pluvinage method is modified in such a way that it can be applied with a reasonable amount of labour to more complex systems. In this modification, the nuclear coordinates act like Fermi–Dirac "particles" filling the energy levels pairwise, while the interelectron coordinates act like Bose "particles", all of which pile into the lowest energy continuum state. An accurate approximation technique is also developed for use in integrating functions containing three or more interelectron coordinates over the space of the nuclear coordinates. The modified Pluvinage approach is used in conjunction with the approximation technique to calculate the ground-state energy of neutral lithium. Internal evidence indicates that the approximation technique is better than 99% accurate in evaluating the individual integrals which appear. Although the wave function used here has no adjustable parameters, it yields an energy value for lithium which is slightly better than the two-parameter value of Wilson.

539.18

1469 $1\,^1S$ AND $2\,^3S$ STATES OF HELIUM.

C.L.Pekeris.

Phys. Rev., Vol. 115, No. 5, 1216-21 (Sept. 1, 1959).

The method described previously for the solution of the wave equation of two-electron atoms has been applied to the $1\,^1S$ and $2\,^3S$ states of helium, with the purpose of attaining an accuracy of 0.001 cm^{-1} in the nonrelativistic energy values. For the $1\,^1S$ state previous calculations have been extended by solving determinants of orders 252, 444, 715, and 1078, the last yielding an energy value of −2. 903 724 375 atomic units, with an estimated error of the order of 1 in the last figure. Applying the mass-polarization and relativistic corrections derived from the new wave functions, a value is obtained for the ionization energy of 198 312.0258 cm^{-1}, as against the value of 198 312.011 cm^{-1} derived previously from the solution of a determinant of order 210. With a Lamb shift correction of −1.339, due to Kabir, Salpeter, and Sucher, this leads to a theoretical value for the ionization energy of 198 310.687 cm^{-1}, compared with Herzberg's experimental value of $198\,310.8_2 \pm 0.15$ cm^{-1}. For the $2\,^3S$ state determinants of orders 125, 252, 444, and 715 have been solved, the last giving an energy value of −2.175 229 378 22 a.u., with an estimated error of the order of 1 in the last figure. This corresponds to a nonrelativistic ionization energy of 38 453.1292 cm^{-1}. The mass-polarization and relativistic corrections bring it up to 38 454.8273 cm^{-1}. Using the value of 74.9 ry obtained by Dalgarno and Kingston for the Lamb-shift excitation energy K_0, a Lamb-shift correction to the ionization energy of the $2\,^3S$ state of −0.16 cm^{-1} is obtained. The resulting theoretical value of 38 454 66 cm^{-1} for the ionization potential is to be compared with the experimental value, which Herzberg estimates to be 38 454.73 ± 0.05 cm^{-1}. The electron density at the nucleus D(0) comes out 33.18416, as against a value of 33.18388 ± 0.00023 which Novick and Commins deduced from the hyperfine splitting. Also determined were expectation values of several positive and negative powers of the three mutual distances, which enter in the expressions for the polarizability and for various sum rules.

539.18

1470 ISOTOPE SHIFT OF He 2P.

G.Araki, K.Mano and M.Ohta.

Phys. Rev., Vol. 115, No. 5, 1222-5 (Sept. 1, 1959).

The isotope shift of the deepest ^3P and ^1P levels of the helium atom is calculated by making use of the wave-functions previously reported by Araki (Abstr. 1801 of 1959). The theoretical values of the specific isotope shift of the ^3P and ^1P levels are -636.00×10^{-3} cm^{-1} and 453.83×10^{-3} cm^{-1}, respectively, which are in fairly good agreement with the observed values $(-642 \pm 5) \times 10^{-3}$ cm^{-1} ($2\,^3P$) and $(461 \pm 5) \times 10^{-3}$ cm^{-1} ($2\,^1P$).

539.18

1471 LAMB SHIFT AND ENERGY LEVEL OF A TIGHTLY BOUND ELECTRON.

D.F.Mayers, G.E.Brown and E.A.Sanderson.

Phys. Rev. Letters, Vol. 3, No. 2, 90 (July 15, 1959).

In calculating the K-absorption edge in mercury to within terms of order αmc^2 the inclusion of the Lamb shift is found markedly to improve the agreement with experiment. Corrections of order $\alpha^2 mc^2$ due to the rearrangement energy and the finite size of the nucleus are found effectively to cancel each other.

R.A.Ballinger

539.18

1472 CALCULATION OF MAGNETIC RESONANCE IN THE GROUND STATE OF ODD ISOTOPES OF MERCURY IN THE PRESENCE OF AN ORIENTING RADIATION.

B.Cagnac and J.P.Barrat.

C.R. Acad. Sci. (Paris), Vol. 249, No. 4, 534-6 (July 27, 1959). In French.

Theoretical analysis of experiments described in Abstr. 13483-4 (1959), using some results of quantum field theory, shows that the quantum result for line breadth is equivalent to that of the macroscopic statistical theory for nuclear spin $\frac{1}{2}$ (Hg^{199}) but not for spin spin $\frac{3}{2}$ (Hg^{201}), though both theories give the same trend as experiment.

J.Hawgood

539.18

1473 PREPARATION OF MIXTURES OF ORTHO- AND PARA-DEUTERIUM.

V.T.Smolyankin and A.I.Shal'nikov.

Pribory i Tekh. Eksper., 1959, No. 1, 150 (Jan.-Feb.). In Russian.

Illustrated description of a method for preparing these mixtures at a pressure close to the atmospheric pressure.

F.Lachman

539.18 : 541.13

ELECTROLYTIC HYDROGEN–DEUTERIUM SEPARATION FACTOR. See Abstr. 748

539.18

1474 FRACTIONATION OF LITHIUM ISOTOPES BY CRYSTALLISATION.

A.E. De Vries.

Z.Naturforsch., Vol.14a, No.8, 764 (Aug., 1959).

By crystallisation from solutions of lithium compounds in water and a few organic solvents separation factors of the order of 1.01 have been obtained. The lithium salt concentrations were calculated from measurements of the weight and volume of the solutions, and the mass ratios were determined by mass spectrometer.

H.C.Cole

539.18

1475 COLLISIONS OF ELECTRONS WITH HYDROGEN ATOMS. IV. EXCITATION OF LYMAN-ALPHA RADIATION NEAR THRESHOLD.

W.L.Fite, R.F.Stebbings and R.T.Brackmann.

Phys. Rev., Vol.116, No.2, 356-7 (Oct., 1959).

By use of improved experimental techniques, the cross-section for excitation of Lyman-alpha radiation in collisions between electrons and hydrogen atoms was remeasured. It was determined that in the threshold region, the results reported previously (Abstr. 6173 of 1959) were somewhat low. The remeasured energy dependence of the cross-section near threshold was found to be as the square root of the excess energy.

539.19 : 539.18

USE OF AN ELECTRONIC COMPUTER FOR THE CONSTRUCTION OF EXACT EIGENFUNCTIONS OF ORBITAL ANGULAR MOMENTUM IN L—S COUPLING.

See Abstr. 1464

539.18 : 539.12

1476 A NOTE ON THE SCATTERING OF ELECTRONS FROM ATOMIC HYDROGEN.

A.Temkin.

Phys. Rev., Vol. 116, No. 2, 358-63 (Oct. 15, 1959).

The distortion of atomic hydrogen by a slowly moving electron at a large distance from the centre of the atom is examined. The problem is the initial phase of a previously described method (Abstr. 5437 of 1958) for the calculation of electron scattering which takes this distortion into account. The initial (static) problem is solved analytically and extended to include higher order effects of the interaction of the electron with the atomic cloud. The construction of a wave-function to describe scattering starting from the solution of the static problem is clarified. This yields as an incidental result a new approximation of the second order perturbation energy associated with the above distortion. A short discussion of the present experimental results for this scattering process is included.

539.18 : 535.33

1477 MEASUREMENT OF INTENSITIES IN THE BALMER SERIES AND DETERMINATION OF THE CONCENTRATION OF EXCITED ATOMS IN A DISCHARGE.

E.Ya.Shreider.

Optika i Spektrosk., Vol. 6, No. 3, 279-83 (March, 1959). In Russian.

The relative intensities and re-absorption of the Balmer lines of hydrogen were measured. From the measured intensities and re-absorption the concentrations of excited atoms in discharges at pressures between 0.25 and 1.5 mm Hg were deduced. The values obtained were of the order of 10^{10} cm^{-3}. The excited-atom concentration fell with pressure and rose linearly with the discharge current. A.Tybulewicz

539.18 : 535.33

1478 EFFECTIVE CROSS-SECTIONS OF EXCITATION OF POTASSIUM SPECTRAL LINES.

L.M.Volkova.

Optika i Spektrosk., Vol. 6, No. 3, 273-8 (March, 1959). In Russian.

An Hanle-type tube with truncated-cone electrodes was used to study the dependence of the effective excitation cross-sections on the incident electron beam energy (up to 60 eV) for eleven lines of potassium lying in the region 4000-4300 A. The lines were recorded photographically or photoelectrically. The cross-sections (in units of 10^{-19} cm^2) were between 0.8 and 20.9 for electron excitation with a 60 eV beam. A.Tybulewicz

539.18

1479 NON-STATIONARY THEORY OF THE STARK BROADENING OF SPECTRAL LINES IN A PLASMA.

L.A.Vainshtein and I.I.Sobel'man.

Optika i Spektrosk., Vol. 6, No. 4, 440-6 (1959). In Russian.

The broadening of atomic lines by charged particles is considered in a non-adiabatic approximation. This makes possible the derivation of several new results while retaining a comparatively simple quasi-classical model. At the velocities of plasma electrons the Weisskopf broadening mechanism is unimportant, and the broadening is due to inelastic processes. It is shown that the width and shift of the lines decrease approximately as 1/v at high velocities, and ions therefore become increasingly important. The line shift is almost entirely due to ions over a wide range of temperatures. The plasma parameters can often be determined more easily from the line shift than from its width. J.B.Sykes

539.18 : 537.56

1480 STARK BROADENING OF HYDROGEN LINES IN A PLASMA.

H.R.Griem, A.C.Kolb and K.Y.Shen.

Phys. Rev., Vol. 116, No. 1, 4-16 (Oct. 1, 1959).

The frequency distributions of hydrogen lines broadened by the local fields of both ions and electrons in a plasma are calculated in the classical path approximation. The electron collisions are treated by an impact theory which takes into account the Stark splitting caused by the quasi-static ion fields. The ion field-strength distribution function used includes the effect of electron shielding and ion—ion correlations. The various approximations that were employed are examined for self-consistency and an accuracy of about 10% in the resulting line profiles is expected. Good agreement with experimental Hβ profiles is obtained while there are deviations of factors of two with the usual Holtsmark theory. Asymptotic distributions for the line wings are given for astrophysical applications. Also here the electron effects are generally as important as the ion effects for all values of the electron density and in some cases the electron broadening is larger than the ion broadening.

539.18

1481 THE SPECTRUM OF Li^+.

G.Herzberg and H.R.Moore.

Canad. J. Phys., Vol. 37, No. 11, 1293-313 (Nov., 1959).

The spectrum of the Li^+ ion was reinvestigated under high resolution in the region 10 000 to 1000 A with a view to determining the Lamb shifts in the ground state and first-excited state. The hyperfine structure of the line 5485 A was studied under improved resolution both with the natural isotopic mixture and with a 96% Li^6 sample. For many of the higher levels the hyperfine structure is larger than the fine structure and for large n and l it is even larger than the singlet—triplet separation. The coupling conditions in these cases are discussed in some detail and theoretical intensity distributions in the combined fine structure and hyperfine structure are presented for comparison with the partially resolved observed structures. The selection rule $\Delta G = 0$ for the quantum number of the total spin $G = I + S$ is found to be obeyed. On the basis of this detailed analysis a table of energy levels of Li^+ is presented including, where possible, the hyperfine splittings. The absolute accuracy of the energy values is only ± 3 cm^{-1} because of the error introduced by the resonance lines at $1\,^1S$-$n\,^1P$ below 200 A not remeasured in the present work. However, the relative accuracy of the levels with reference to the $2\,^3S$ level is considered to be within ± 0.05 cm^{-1} in most cases. The limits of the observed series have been determined with an accuracy of $\pm 0.1_0$ cm^{-1} and lead to an ionization potential of $I.P._{exp}(Li^+) = 610079._4$ cm^{-1} with an error (± 3 cm^{-1}) caused entirely by the error in the resonance lines. The term values (ionization potentials) of the $2\,^3S$ and $2\,^1S$ states, $T(2\,^3S) = 134044.19 \pm 0.10$ cm^{-1}, $T(2\,^1S) = 120008.30 \pm 0.10$ cm^{-1} are much more accurate. The difference of the observed ionization potential of Li^+ and that calculated from relativistic quantum mechanics is -8.0 ± 3 cm^{-1}, which agrees within the rather large limit of error with the predicted Lamb shift (-7.8 cm^{-1}).

539.18

1482 N^{14}—N^{15} HYPERFINE ANOMALY.

L.W.Anderson, F.M.Pipkin and J.C.Baird, Jr.

Phys. Rev., Vol. 116, No. 1, 87-98 (Oct. 1, 1959).

The optical transmission of an optically oriented sodium vapour in spin-exchange equilibrium with atomic nitrogen was used to measure the zero-field hyperfine splitting of N^{14} and N^{15}. The ground state of atomic nitrogen is $^4S_{3/2}$. For N^{14}, which has I = 1,

$$\Delta\nu_{5/2\to 3/2} = 26.127\,21 \pm 0.000\,18 \text{ Mc/s},$$
$$\Delta\nu_{3/2\to 1/2} = 15.676\,46 \pm 0.000\,12 \text{ Mc/s}.$$

For N^{15}, which has $I = \frac{1}{2}$,

$$\Delta\nu = 29.291\,36 \pm 0.000\,16 \text{ Mc/s}.$$

The nuclear moments of N^{14} and N^{15} were measured by observing the effect of saturating the nitrogen resonance on the proton resonance in NH_4^+. The results were

$$g(14)/g(H^1) = 0.072\,236\,95 \pm 0.000\,000\,08,$$

and

$$g(15)/g(H^1) = -0.101\,330\,93 \pm 0.000\,000\,08.$$

The N^{14}—N^{15} hyperfine anomaly obtained by combining these measurements is

$$\Delta = \frac{A(15)/A(14)}{g(15)/g(14)} - 1 = 0.000\,983 \pm 0.000\,017.$$

A short discussion of the mechanism of spin-exchange collisions is given.

539.18

1483 HYPERFINE STRUCTURE OF $_{36}Kr^{83}$.

F.Bayer-Helms.

Z. Phys., Vol.154, No.2, 175-81 (1959). In German.

Using an enriched mixture of isotopes, known term-splittings for Kr^{83} are confirmed and the hyperfine structure of several 3p-terms (Paschen notation) are redetermined. Seventeen lines between 4263 A and 6083 A were investigated. The splitting factors are calculated by means of the theory of intermediate coupling, and a value for the quadrupole moment of the nucleus of the order of 0.2×10^{-24} cm^2 is obtained.

P.Young

539.18

1484 MEASUREMENT OF THE ZEEMAN g_J FACTORS FOR THE TWO YTTRIUM GROUND STATES $^2D_{3/2}$ AND $^2D_{5/2}$ WITH THE ATOMIC BEAM RESONANCE METHOD.

S.Penselin.

Z. Phys., Vol. 154, No. 2, 231-7 (1959). In German.

The ratio of the splitting factors, g_J, for Y^{89} in the $^2D_{3/2}$ and $^2D_{5/2}$ states to that for Ag^{107} in the $^2S_{1/2}$ ground state, were calculated from simultaneous measurements of the frequencies of transitions between the corresponding Zeeman components of a hyperfine structure term ($\Delta F = 0$) for Y^{89} and Ag^{107}, in fields from 470-490 Oe.

A.J.Manuel

539.18

1485 MEASUREMENT OF THE HYPERFINE STRUCTURE SPLITTINGS OF THE TWO YTTRIUM GROUND STATES $^2D_{3/2}$ AND $^2D_{5/2}$ WITH THE ATOMIC BEAM RESONANCE METHOD.

G.Fricke, H.Kopfermann and S.Penselin.

Z. Phys., Vol. 154, No. 2, 218-30 (1959). In German.

High frequency transitions between the Zeeman components of different hyperfine structure terms ($\Delta F = 1$) in fields of 10-15 Oe, and single hyperfine structure terms ($\Delta F = 0$) in fields of 470-490 Oe, were observed for Y^{89} atoms, from which $A(^2D_{3/2}) = -(57\,217 \pm 0.015)$ Mc/s and $A(^2D_{5/2}) = -(28\,749 \pm 0.030)$ Mc/s were calculated.

A.J.Manuel

539.18

1486 THE RECOMBINATION AND "MINUS" CONTINUA OF OXYGEN ATOMS.

G.Boldt.

Z. Phys., Vol. 154, No. 3, 319-29 (1959). In German.

The continuum emitted by an arc burning in O was measured at 10 500-13 000°K in the range 4300-6300 A. When the free-free continuum of the electrons in the field of positive ions has been allowed for, there remains a continuum composed of the recombination and the "minus" spectrum of the atoms. The absorption coefficients of both kinds of continuun are given, viz. per atom or ion with unit negative charge (per 1 cm^3). The coefficient of the "minus" continuum is, in the case under examination, 10^4-10^5 times greater than that of the recombination continuum; the intensities of both continua are of the same order. The "minus" continuum can be interpreted mostly as the electron-affinity continuum.

F.Lachman

539.18

1487 THE RECOMBINATION AND "MINUS" CONTINUA OF NITROGEN ATOMS.

G.Boldt.

Z. Phys., Vol. 154, No. 3, 330-8 (1959). In German.

The continuum emitted by an arc burning in N was measured at the same conditions as described in the preceding abstract. The coefficient of the "minus" continuum is (for pure N, 1 atm) about 10^5 times as great as that of the recombination continuum. Again, the "minus" continuum can be mostly interpreted as the electron-affinity continuum of the excited metastable N atoms.

F.Lachman

539.18

1488 INVESTIGATIONS ON CHANGES IN INTENSITY RATIOS IN THE SPECTRA OF COPPER-ZINC ALLOYS ON ADDITION OF A THIRD ALLOYING COMPONENT.

J. van Calker and H.Braunisch.

Z. angew. Phys., Vol. 11, No. 7, 247-55 (July, 1959). In German.

The effect on intensity ratio of up to 5% of Al, Sn, Mn or Pb is determined. The effect varies with the lines chosen and is greater for spark than arc lines; it is different when the discharge is in a N_2 atmosphere. Correction factors to obtain the true Cu content can be applied when the amount of third component is so small that its presence causes no new crystal form to appear.

G.F.Lothian

539.18

1489 DEPOLARIZATION OF MU-MESONS IN HYDROGEN.

S.S.Gershtein.

Zh. eksper. teor. Fiz., Vol. 34, No. 4, 993-4 (April, 1958). In Russian. English translation in: Soviet Physics--JETP (New York), Vol. 34 (7), No. 4, 685-6, (Oct., 1958).

A previous calculation (Abstr. 7427 of 1958) showed that the mu-mesons in mesic hydrogen atoms would be completely depolarized by collisions with hydrogen atoms resulting in transitions from the upper to the lower hyperfine structure state. A similar calculation for the more realistic case of collisions with hydrogen molecules leads to the same conclusion, the cross-sections being about three times larger in this case.

A.Ashmore

539.18

1490 THE POLARIZATION OF NUCLEI BY CAPTURE OF POLARIZED μ^--MESONS INTO MESO-ATOMIC K-SHELLS.

I.M.Shmushkevich.

Zh. eksper. teor. Fiz., Vol. 36, No. 3, 953-4 (1959). In Russian.

In the capture of polarized μ-mesons into atomic K-shells by unpolarized nuclei of spin I, the hyperfine splitting between $F = I + \frac{1}{2}$ and $F = I - \frac{1}{2}$, can be established in a time which is short compared with the life-time of the μ-meson. Since the only initial direction specified is along the μ-meson spin, unit vector j, the final density matrix can be written,

$$\rho_F = \frac{1}{2F+1}\left(1 + \frac{3\lambda_F}{F+1} j.F\right) P_F,$$

where P_F is a projection operator. The parameter λ_F has absolute value ≤ 1. Even for the case $I = \frac{1}{2}$, ρ_+ and ρ_- are in general different, so that this effect should be taken into account in calculating the distribution of neutrons in $\mu^- + p \rightarrow n + \nu$. This has not been done in such calculations to date (Abstr. 2486, 2592, 3303 and 3305 of 1958). [English Summary: PB 141052T-11, obtainable from Office of Technical Services, U.S. Dept. of Commerce, Washington, D.C., U.S.A.].

G.P.McCauley

MOLECULES

539.19

1491 THE DISSOCIATION AND IONIZATION OF COMETARY MOLECULES IN THE SOLAR RADIATION FIELD.

V.I.Cherednichenko.

Astron. Zh., Vol. 36, No. 2, 254-63 (1959). In Russian.

Using present data on the concentration and velocity of solar corpuscles and on the intensity of solar photon radiation, together with empirical relations for calculating effective cross-sections of ionization, dissociation and re-charge of cometary molecules and atoms in collision with solar protons, the life-times of the assumed parent molecules (H_2O, CH_4, CO_2, NH_3, C_2N_2, C_3H_6, C_2H_2, N_2, O_2, H_2) and observed cometary molecules and radicals (C_2, CN, N_2^+, CO_2^+, C_3, CO^+, OH, OH^+, CH, CH^+, NH, NH_2), are calculated. Transformation schemes showing life-times are given for the most probable cases, The distance of the comet from the Sun (r) is taken as 1 AU. The variation of the diameter of the head of Halley's comet (1910 II) in C_2 IV emission for $0.6 \leq r \geq 2.3$ AU is hence found and the result compared with observation.

G.A.Chisnall

539.19

1492 COLLISION THEORY OF THE KINETICS OF DISSOCIATION OF DIATOMIC MOLECULES.

B.Widom.

J. chem. Phys., Vol. 31, No. 4, 1027-9 (Oct., 1959).

A collision theory is developed for the rate of dissociation of diatomic molecules dilutely dispersed in an inert gas, the theory being identical in its basic structure to the collision theory of Rice [Monatshefte für Chemie, Vol. 90, 330(1959)] but differing from the latter in some of the details. The rate constant is found to be

$$\kappa = c(\mu^{\frac{1}{2}} A^{\frac{1}{2}} / \hbar r_0{}^2)\, Z \exp(-D/kT),$$

where Z is the collision number, D the dissociation energy, μ the reduced mass of the diatomic molecule, r_0 its equilibrium internuclear distance, A the magnitude of the coefficient of the attractive r^{-6} term in the long-range interaction energy of the two atoms of its diatomic molecule, and c a dimensionless constant estimated to be 0.27.

539.19

1493 CONTRIBUTION TO THE STUDY OF MOLECULAR WAVE FUNCTIONS.

C.Vroelant.

Cahiers de Phys., Vol. 12, 48-60 (Feb., 1958). In French.

Continues the "spin-state" method of Abstr. 7444 (1959) for obtaining approximate wave functions, gives some examples of its application to aromatic molecules, and compares it with the usual LCAO MO method and some of the approximations to it.

J.Hawgood

539.19 : 551.5

1494 INTERPRETATION OF ROTATIONAL TEMPERATURES OF AURORAL N_2^+ BANDS. I. PROTON IMPACT AT INTERMEDIATE ENERGIES.

F.L.Roesler, C.Y.Fan and J.W.Chamberlain.

J. atmos. terrest. Phys., Vol. 12, No. 2-3, 200-5 (1958).

Laboratory experiments have been performed to find the rotational temperature of the first negative bands of N_2^+ when nitrogen is excited by proton collisions at energies between 10 and 30 keV. In this range there is little difference between the gas temperatures and the apparent (rotational) temperatures obtained by proton excitation. The question of the correspondence between auroral N_2^+ temperatures and the gas temperatures in the high atmosphere is reviewed.

539.19

1495 THE PRESSURE-INDUCED ROTATIONAL ABSORPTION SPECTRUM OF HYDROGEN. II. ANALYSIS OF THE ABSORPTION PROFILES.

Z.J.Kiss and H.L.Welsh.

Canad. J. Phys., Vol.37, No.11, 1249-59 (Nov., 1959).

The experimental profiles obtained in Pt 1 (see Abstr. 7962 of 1959) for the pressure induced absorption of H_2 and H_2—foreign gas mixtures in the region 300-1400 cm^{-1} are separated by a semi-empirical method into rotational and translational parts. The pressure-induced rotational lines of H_2 are shown to have a dispersion line shape, modified by the Boltzmann law. The intensities of the rotational parts of the spectra are, on the average, 13% greater than those calculated in Pt I on the assumption of quadrupole interaction alone; the residual experimental intensity probably represents the effect of overlap interaction. The intensities of the translational parts of the spectra are of the same order of magnitude as the translational intensities in mixtures of the rare gases. Some additional experimental data on double rotational transmission and on the anomalous density variation of the absorption in H_2—Xe mixtures are given.

539.19

1496 NORMAL VIBRATION FREQUENCIES AND THERMODYNAMIC FUNCTIONS OF TITANIUM TETRAIODIDE.

N.I.Ushanova, I.N.Godnev and I.V.Orlova.

Optika i Spektrosk., Vol. 5, No. 5, 567-70 (1958). In Russian.

Reports an approximate calculation of normal vibration frequencies and thermodynamic functions of TiI_4 using the method described by Sverdlin (1958) and Godnev, Sverdlin and Ushanova (1957). The equilibrium distance r_0 between Ti and I in TiI_4 was taken as $r_0 = 2.52$ A. The calculated normal vibration frequencies were: $\nu_1\ (A_1) = 163$, $\nu_2\ (E) = 51$, $\nu_3\ (F_2) = 318$ and $\nu_4\ (F_2) = 67\ cm^{-1}$. Thermodynamic functions were found, assuming harmonic vibrations and rigid rotations, for gaseous TiI_4 at 1 atm pressure and 298.2, 400, 600, 800 and 1000°K.

A.Tybulewicz

539.19

1497 ROTATIONAL ANALYSIS OF THE BAND SYSTEMS OF YTTRIUM OXIDE.

U.Uhler and L.Åkerlind.

Naturwissenschaften, Vol. 46, No. 16, 488 (1959). In German.

Preliminary note of rotational constants obtained from analysis of the 0,0 bands of yttrium oxide for the systems corresponding to $^2\Sigma-{}^2\Sigma$ and $^2\Pi-{}^2\Sigma$ transitions.

R.C.Seymour

539.19

1498 THE RELATIONSHIP BETWEEN THE KINEMATIC COEFFICIENT MATRIX AND THE RECIPROCAL MATRICES OF KINETIC ENERGY IN THE PROBLEM OF MOLECULAR VIBRATIONS.

I.N.Godnev and I.V.Orlova.

Optika i Spektrosk., Vol. 6, No. 5, 583-8 (May, 1959). In Russian.

The authors discuss the use of Lagrange's equations, from which holonomic constraints are not excluded, in solution of the problem of molecular vibrations in dependent coordinates. Formulae are deduced which relate the kinematic coefficient matrix A with the matrices T^{-1} and T_0^{-1}, where T and T_0 are the kinetic energy matrices for dependent and independent coordinates respectively.

A.Tybulewicz

539.19

1499 VIBRATIONAL SPECTRA OF SILICATES. II. INTERPRETATION OF THE SPECTRA OF GLASSES.

B.I.Stepanov and A.M.Prima.

Optika i Spektrosk., Vol. 5, No. 1, 15-22 (1958). In Russian. English summary: PB 141047T-6, obtainable from Office of Technical Services, U.S. Dept. of Commerce, Washington, D.C., U.S.A.

For Pt I, see Abstr. 12046 (1959). A detailed discussion of the experimental results of Pt I on the frequencies and forms of vibrations of a number of silicate crystals is given and used to interpret Raman and infrared spectra of the silicate glasses and of crystals.

R.W.Nicholls

539.19

1500 POWER SATURATION OF THE J = 1 → 2 ROTATIONAL TRANSITION OF OCS.

A.Dymanus.

Phys. Rev., Vol. 116, No. 2, 351-5 (Oct. 15, 1959).

The power saturation of seven lines arising from the J = 1 → 2 rotational transition in OCS was investigated with a Stark-cavity spectrometer. The experimental results on all investigated lines confirm the theory of Karplus and Schwinger (Abstr. 2424 of 1948) adapted in this paper to the case of gas enclosed in a cylindrical cavity absorption cell oscillating in a TE_{omn} mode with an arbitrary n-value, and m-value from 1 to 10.

539.19

1501 POTENTIAL FIELD AND FORCE CONSTANTS OF SOME TRIGONAL BIPYRAMIDAL PENTAHALIDES.

P.C.Haarhoff and C.W.F.T.Pistorius.

Z. Naturforsch., Vol. 14a, No. 11, 972-4 (Nov., 1959).

The valency-type force constants of PF_5, PCl_5, SbF_5, $SbCl_5$, $NbCl_5$ and $TaCl_5$ are evaluated by means of Wilson's F–G matrix method, using existing infrared and Raman data. Anharmonicity is not taken into account.

539.19

1502 COMPOUNDS OF TERBIUM WITH BORON AND THE ELECTRONIC CONFIGURATION OF THE TERBIUM ATOM.

Yu.B.Paderno, T.I.Serebryakova and G.V.Samsonov.

Dokl. Akad. Nauk SSSR, Vol. 125, No. 2, 317-18 (1959). In Russian.

Two electronic configurations, $4f^85d^16s^2$ and $4f^96s^2$ are possible for the Tb atom in MB_6 compounds. TbB_6 was prepared by $Tb_2O_3 + 3B_4C = 2TbB_6 + 3CO$ and $Tb_2O_3 + 15B = 2TbB_6 + 3BO$. X-ray powder diffraction data for TbB_6 and TbB_4 are given. TbB_6 is cubic with a = 4.11 A with an O'_h-type structure. TbB_4 is tetragonal with a = 7.13, c = 4.07 A. The work function for TbB_6 was found to be $\varphi = 3.1$ eV. The $4f^85d^16s^2$ configuration is more probable.

A.L.Mackay

539.19

1503 TUNNEL TRANSITIONS BETWEEN SYSTEMS DESCRIBED BY THE MORSE POTENTIAL CURVES.

V.I.Gol'danskii.

Dokl. Akad. Nauk SSSR, Vol. 127, No. 5, 1037-40 (Aug. 11, 1959). In Russian.

Presents the solution of a tunnel transition from a molecular state described by one Morse curve to a state described by another such curve. Expressions are given for the condition of formation of the potential barrier, and for the probability of the tunnel transition. It is also shown that the criterion suggested in a previous paper [Dokl. Akad. Nauk SSSR, Vol. 124, No. 6, 1261 (1959)], which characterizes the limit of the temperature region where the tunnel effect plays a preponderant part, is generally valid and applicable also for the quantum energy distribution.

F.Lachman

539.19

1504 ELECTRON AFFINITY OF O_2.

R.S.Mulliken.

Phys. Rev., Vol. 115, No. 5, 1225-6 (Sept. 1, 1959).

It is shown, using molecular orbital theory and experimental data, that 0.15 eV is much the more probable of two alternative values for the electron affinity of O_2 which have been considered. Thermochemical evidence favouring a value of 0.9 eV is rather uncertain and should be given less weight.

539.19

1505 PROTON RESONANCE SPECTRA OF CYCLOPENTADIENE, METHYL CYCLOPENTADIENE, CYCLOHEPTATRIENE AND TRIMETHYL SILICON CHLORIDE.

W.Strohmeier, E.Lombardi and R.M.Lemmon.

Z. Naturforsch., Vol. 14a, No. 2, 109-12 (Feb., 1959). In German.

The proton chemical shifts were determined with reference to cyclohexane. The monomer of cyclopentadiene has two sharp resonance lines with chemical shift $\delta_{CH} = 1.1$ p.p.m. and

$\delta_{CH_2} = -2.5$ p.p.m. The four CH protons are equivalent. The monomer of methylcyclopentadiene shows hyperfine splitting. Three groups of lines were observed corresponding to the CH, CH_2 and CH_3 protons. The dimerization of cyclopentadiene and methyl cyclopentadiene with time was studied via the proton resonance. The spectrum of cycloheptatriene shows that the α,β and γ protons are not equivalent. For trimethyl silicon chloride $\delta_{CH_3} = -4.8$ p.p.m. The chemical shifts of cyclopentadiene and methyl cyclopentadiene dissolved in cyclohexane are concentration independent for the range 0.2 to 0.8 molar.

J.G.Powles

539.19

1506 THE DIFFERENCE IN THE PROTON RESONANCE SPECTRA OF CYCLOPENTADIENYL–METAL COMPOUNDS WITH "SANDWICH" STRUCTURE AND WITH LOCALIZED METAL–CARBON BONDING.

W.Strohmeier and R.M.Lemmon.

Z. Naturforsch., Vol. 14a, No. 2, 109-12 (Feb., 1959). In German.

An investigation of the compounds, ferrocene, 1-1^1 dimethyl ferrocene, cyclopentadienyl manganese carbonyl, methyl cyclopentadienyl manganese tricarbonyl, dicyclopentadienyl mercury and cyclopentadienyl trimethyl silicon. The chemical shifts are related to the varying aromatic character of the cyclopentadienyl ring and are used to deduce whether or not local metal carbon bonding occurs. An analysis of mixtures of these compounds by proton resonance methods is possible.

J.G.Powles

539.19

1507 STRONG COUPLING IN NUCLEAR RESONANCE SPECTRA. II. FIELD DEPENDENCE OF SOME UNSYMMETRICAL THREE-SPIN SPECTRA.

R.W.Fessenden and J.S.Waugh.

J. chem. Phys., Vol. 31, No. 4, 996-1001 (Oct., 1959).

For Pt I, see Abstr. 8367 (1959). Magnetic resonance spectra are calculated and compared with experiment for the vinyl group of styrene, 2,4-dichloroaniline, and 2,5-dichloroaniline at various magnetic field strengths. Some simple rules are presented which facilitate the determination of chemical shifts and coupling constants, including the signs of the latter. One of the spectra illustrates the occasional necessity for experiments at more than one field strength if the parameters are to be determined unambiguously. In each case the shielding and coupling constants are found to be field-independent within experimental accuracy.

539.19

1508 INFLUENCE OF SUBSTITUENTS ON THE QUADRUPOLE COUPLING CONSTANT OF CHLORINE.

E.Scrocco, P.Bucci and M.Maestro.

J. Chim. phys., Vol. 56, No. 7, 623-30 (July, 1959). In French.

The approximate theory of separated electron pairs (Abstr. 9096 of 1958) is applied to the explanation of the additivity of substituent shifts of absorption frequencies in chloromethanes, chlorobenzenes, etc. It is shown that the nuclear quadrupole coupling constants of corresponding chlorine atoms in a series of such molecules, and hence the frequency shifts, depend linearly on the "bond polarity parameter" which describes the variations of electrostatic field, at the C–Cl bond, produced by the substituents.

J.Hawgood

539.19

1509 ALLOWANCE FOR HYBRIDIZATION IN THE CASE OF HYDROGEN MOLECULE. F.Berencz.

Acta phys. Hungar., Vol. 10, No. 1, 93-9 (1959). In German.

The magnitude of the effect due to the polarization of the electron cloud of atoms being allowed for is shown, in the case of molecular bonds, to be roughly as important as that due to the correlation of electrons being taken into consideration. Numerical calculations are carried out for hydrogen molecule.

F.Lachman

539.19

1510 LENGTHS OF CC "SINGLE" BONDS AND RADII OF HYBRID ORBITALS OF CARBON. G.R.Somayajulu.

J. chem. Phys., Vol.31, No.4, 919-21 (Oct., 1959).

The variation in the CC σ bond length in hydrocarbons and related compounds is ascribed primarily to the variation in the covalent radius of the carbon atom with hybridization, resonance effects being considered to be of little importance in the ground states of these molecules. Values for the radii of the hybrid orbitals of carbon are assigned, and they are shown to reproduce satisfactorily the lengths of the CC σ bonds in a variety of compounds, both aliphatic and aromatic.

539.19

1511 LCAO WAVE FUNCTIONS FOR HYDROGEN FLUORIDE WITH HARTREE–FOCK ATOMIC ORBITALS.

A.M.Karo and L.C.Allen.

J. chem. Phys., Vol. 31, No. 4, 968-77 (Oct., 1959).

Accurate Hartree–Fock fluorine functions and an exponential Slater 1s hydrogen orbital are used as basis functions in a conventional SCF LCAO-MO treatment of the HF molecule at five internuclear distances. Comparison with Hartree–Fock calculations for the isoelectronic F^- and Ne systems gives a qualitative indication that a rather close approximation to the true molecular Hartree–Fock solution for HF has been achieved. Configuration interaction is included with the restriction that the 1σ orbital remains filled. Molecular energies, dipole moments, and other molecular quantities are evaluated and compared with experimental results and with other theoretical work.

539.19 : 539.2

NEW METHOD FOR CALCULATING WAVE FUNCTIONS IN MOLECULES. See Abstr. 1538

539.19

1512 BOND ENERGIES AND THE INTERACTIONS BETWEEN NEXT-NEAREST NEIGHBORS. I. SATURATED HYDROCARBONS, DIAMOND, SULFANES, S_8, AND ORGANIC SULFUR COMPOUNDS. T.L.Allen.

J. chem. Phys., Vol. 31, No. 4, 1039-49 (Oct., 1959).

Interaction energies of atoms which are next-nearest neighbours were determined from thermodynamic data for a number of carbon and sulphur molecules. When these interactions are taken into account, bond energies are found to be constant to a high degree of precision. Additional factors which were considered include thermal and zero-point energies, interactions of more distant neighbours, trigonal interactions, and ring strain. Simple equations for the prediction of unknown heats of formation are developed.

539.19

1513 ETHANE CARBON–CARBON DISTANCE OBTAINED FROM INFRARED SPECTRA.

H.C.Allen, Jr. and E.K.Plyler.

J. chem. Phys., Vol. 31, No. 4, 1062-5 (Oct., 1959).

The parallel band of ethane at 2753 cm^{-1} and the parallel band of ethane-d_6 at 2816 cm^{-1} were observed and analysed. The resultant values of B for C_2H_6 and C_2D_6 are 0.6637 cm^{-1} and 0.4598 cm^{-1}, respectively. From these B values the C–C distance is found to be 1.534 A and the quantity:

$$(r_{CC/2} + r_{CH}\cos\theta)^2 + r_{CH/2}^2 \sin^2\theta = 1.866\text{A where } \theta = 180 - \angle_{HCC}.$$

If the r_{CH} value of methane (1.093 A) is assumed, $\angle_{HCC}$ is 109° 45'.

539.19

1514 H_3 ACTIVATED COMPLEX AND THE RATE OF REACTION OF HYDROGEN ATOMS WITH HYDROGEN MOLECULES. R.E.Weston, Jr.

J. chem. Phys., Vol.31, No.4, 892-8 (Oct., 1959).

The method proposed by Sato [Abstr. 5687 of 1955; 2493 of 1956 and Bulletin of the Chemical Society of Japan, Vol.28, 450 (1955)] for determining potential surfaces is compared with the semiempirical method of Eyring and co-workers. The two methods are found to be equally empirical. The potential energy surface for the H_3 complex was constructed with the Sato method to give an activation energy which agrees with the experimental value. The H_3 complex is found to be linear and symmetrical, with a bond length of 0.93 A and vibrational frequencies of 2108, 877, and 1918i cm^{-1}. Anharmonicity constants for the real frequencies make a negligible contribution to the zero-point energy. A large contribution to the $H + H_2$ reaction from tunnelling through the potential barrier is predicted, contrary to experimental data. However, at 1000°K, the calculated pre-exponential factor and ratios of rate constants for isotopic species are in reasonably good agreement with experimental values.

539.19

1515 FORCE PARAMETERS FOR SOME NONPOLAR MOLECULES ON THE EXP 6–8 MODEL. A.K.Barua.

J. chem. Phys., Vol. 31, No. 4, 957-60 (Oct., 1959).

Force parameters for the Buckingham–Corner (exp 6–8) potential are calculated for Kr, Xe, and C_2H_4. For Kr and Xe, crystal data and second virial data were used. Crystal data could not be used for C_2H_4. For these substances the exp 6–8 potential was compared with the other potential forms. It is observed that the second virial coefficient is not sensitive enough to show the relative importance of the contributions of the r^{-6} and r^{-8} terms to the London attractive potential.

539.19

1516 N.M.R. STUDY OF γ-RAY INDUCED POLYMERISATION OF ETHYL ACRYLATE.

T.Shibata, I.Kimura and T.Suita.

J. Phys. Soc. Japan, Vol. 13, No. 12, 1546-7 (Dec., 1958).

The proton resonance line-width increases as the amount of polymerization increases. E.F.W.Seymour

539.19

1517 PHOTOMETRIC INVESTIGATIONS OF ALKALI METALS IN HYDROGEN FLAME GASES. III. THE SOURCE OF THE ALKALI METAL CONTINUUM.

C.G.James and T.M.Sugden.

Proc. Roy. Soc. A, Vol. 248, 238-47 (Nov. 11, 1958).

For Pt II, see Abstr. 4714 (1956). When traces of alkali elements are present in the burnt gases of hydrogen + oxygen + nitrogen mixtures, a weak continuous emission, extending from the red into the near ultraviolet (~ 3000 A), is observed, in addition to some atomic lines of the alkalies. This continuum has been examined as a function of the nature and concentration of the additive, and of the temperature and composition of the flame gases. The observed small variation of the intensity of the continuum with temperature and the correlation of the intensity with the concentration of hydroxyl in the gases have led to the conclusion that the origin of the continuum lies in a radiative process

$$A + OH \rightarrow AOH + h\nu,$$

where A represents an atom of alkali element. The results are not consistent with the previously held views that the continuum arises from a radiative recombination of oppositely charged particles. The possible use of the intensity of the continuum as a measure of concentration of hydroxyl is discussed.

539.19

1518 PHOTOMETRIC INVESTIGATIONS OF ALKALI METALS IN HYDROGEN FLAME GASES. IV. THERMAL AND CHEMILUMINESCENT EFFECTS PRODUCED BY FREE RADICALS.

P.J.Padley and T.M.Sugden.

Proc. Roy. Soc. A, Vol. 248, 248-65 (Nov. 11, 1958).

The intensity of emission of the sodium D-lines has been observed as a function of height above the burner for traces of sodium salts added to premixed hydrogen + oxygen + nitrogen flames burning at atmospheric pressure. A specially constructed Mèker burner was used, giving an almost flat reaction zone. Flames in which the final temperatures of the burnt gas ranged from 1400 to 2500°K were used. At the higher final temperatures, the intensity showed a rapid rise at the reaction zone, followed by a more steady rise to a constant value. This has been interpreted as a thermal effect, the bulk temperature of the flame gases increasing by significant amounts as a result of heat released by the recombination reactions

$$H + H + X \rightarrow H_2 + X,$$
$$H + OH + X \rightarrow H_2O + X.$$

Values of the mean velocity constants of these ternary reactions have been deduced, and are in agreement with independent estimates. At the lower final temperatures, there is a sharp peak of intensity at the reaction zone, followed by a decrease towards a steady value. This has been interpreted as a chemiluminescent effect, the sodium being excited by ternary reaction with two free radicals:

$$H + H + Na \rightarrow H_2 + Na^*,$$
$$H + OH + Na \rightarrow H_2O + Na^*.$$

The decay of chemiluminescence with height in the flame gases accords with the known decreases of the concentrations of atomic hydrogen and hydroxyl. Relative and absolute velocity constants for these processes are derived and discussed.

539.19

1519 ABNORMAL EXCITATION OF OH IN $H_2/O_2/N_2$ FLAMES.

W.E.Kaskan.

J. chem. Phys., Vol. 31, No. 4, 944-56 (Oct., 1959).

The emission from the first four vibrational levels of $OH^2\Sigma^+$ and the concentrations of ground state $OH^2\Pi$ were measured in a series of rich $H_2/O_2/N_2$ flames held on flat porous burners as a function of distance from the burner. The intensity of emission of each of the bands is proportional to the cube of the concentration of ground state OH, but the constant of proportionality depends on the band and the flame conditions. This dependence, as well as absolute intensity measurements, establish the fact that the radiation is nonthermal. The dependence of the emission intensity on an integral power of OH strongly indicates that the excited OH is formed as a result of one or more of a set of possible radical recombination reactions. It is shown that in general is it not possible to obtain a unique determination of the excitation mechanism for any band. The only exception to this is that definite evidence for the preassociation reaction, $O + H \rightarrow OH^2\Sigma$, $v = 2$, was obtained. The vibrational distributions of excited OH are shown to be consistent with "temperatures" from 3000° to 5000°K (compared with maximum flame gas temperatures of 1600°K), which is probably to be expected from a reaction with the exothermicity of $H + OH + OH \rightarrow H_2 + OH^*$. It is concluded from this and from the general behaviour of the data, that this last reaction is most likely responsible for the nonthermal emission of all the bands, with the exception of that specifically known to be due to the pre-association reaction.

539.19 : 535.33 : 537.52

1520 SPECTRUM OF A GLOW DISCHARGE IN NITROGEN—HYDROGEN MIXTURES AT HIGH PRESSURES.

A.L.Stolov.

Optika i Spektrosk., Vol. 5, No. 5, 626-8 (1958). In Russian.

Reports studies of spectra of glow discharges in pure nitrogen, in nitrogen with oxygen and organic impurities, in hydrogen, in nitrogen—hydrogen mixtures, and in ammonia. Measurements were made in a wide range of pressures (1-76 cm Hg) using d.c. discharges (0.1 A, 900 V). The spectra were found to be the same for three types of discharges: high-frequency (13 Mc/s), double-electrode, and single-electrode ("flame"). Variations between spectra obtained from different portions of the same discharge (e.g. the positive column or the negative-emission region) were observed.

A.Tybulewicz

539.19 : 535.33

1521 EXCITATION FUNCTIONS OF CERTAIN BANDS OF THE SECOND POSITIVE SYSTEM OF N_2.

S.M.Kishko and M.Yu.Kuchinka.

Optika i Spektrosk., Vol. 6, No. 5, 580-2 (May, 1959). In Russian.

Nitrogen molecules were excited with an electron beam of 10^{-3}A/cm^2 intensity at pressures from 10^{-2} to 4×10^{-3}mm Hg. These conditions ensured the absence of multiple collisions, collisions of the second kind, and step-wise excitation. The optical excitation functions were obtained for $0 \rightarrow 3(\lambda = 4059.4$ A), $1 \rightarrow 4(\lambda = 3998.4$ A) and $2 \rightarrow 6(\lambda = 4200.5$ A) bands of the second positive system of N_2, corresponding to the transition $C^3\Pi \rightarrow B^3\Pi$. The excitation curves (band intensity versus accelerating voltage of the electron source) of the three bands obtained at 4.5×10^{-3} mm Hg had one maximum at 18 V. With increase of pressure to 10^{-2} mm Hg this maximum shifted to 17 V, due to multiple collisions. A.Tybulewicz

539.19

1522 SPECTRAL STUDY OF A VISIBLE, SHORT-DURATION AFTERGLOW IN NITROGEN.

G.E.Beale, Jr, and H.P.Broida.

J. chem. Phys., Vol. 31, No. 4, 1030-4 (Oct., 1959).

In the discharge products of rapidly flowing, pure nitrogen at pressures between 4 and 15 mm Hg, an afterglow differing from the usual Lewis—Rayleigh afterglow was found to occur approximately 5 msec after the discharge. This pink-coloured afterglow persists for about 2 msec and is both preceded and followed by the usual yellow glow of active nitrogen. In the visible and near ultraviolet, this short-duration glow is characterized by strong emission of N_2^+ $(B^2\Sigma_u^+ - X\,^2\Sigma_g^+)$ and N_2 1st positive $(B\,^3\Pi_g - A\,^3\Sigma_u^+)$ bands and weak emission of N_2 2nd positive $(C\,^3\Pi_u - B\,^3\Pi_g)$ bands. The vibrational intensity distributions of the bands are similar to that of the discharge, including strong emission from vibrational levels above the predissociation limit of the $B\,^3\Pi_g$ state. The existence of this afterglow shows the presence of highly energetic species other than nitrogen atoms after the discharge.

539.19

1523 ON THE PROBLEM OF COLLISIONS OF THE SECOND KIND IN A MIXTURE OF GASES N_2 + A.

V.P.Sўchev.

Optika i Spektrosk., Vol. 6, No. 3, 419-22 (March, 1959). In Russian.

To find whether the reported high intensity of the second positive system of nitrogen bands in N_2-A discharges is due to collisions between metastable argon atoms and nitrogen molecules, the ratio of the effective cross-section for such collisions (Q) to the cross-section for collisions between electrons and nitrogen molecules (Q_1) was calculated. It was found that, at a total pressure of 1 mm Hg (argon pressure 0.88 mm Hg) and 400°K, the ratio Q/Q_1 was of the order of 0.01, i.e. the second-kind collisions are, under the conditions considered, of little importance compared with electron collisions (collisions of the first kind). A.Tybulewicz

539.19

1524 TEMPERATURE DEPENDENCE OF THE CROSS-SECTION FOR ABSORPTION OF VISIBLE LIGHT BY NITROGEN DIOXIDE.

V.N.Soshnikov.

Optika i Spektrosk., Vol. 6, No. 3, 315-22 (March, 1959).
In Russian.

The author used 300°K data reported by Hertzberg and Teller (1933) to obtain the differential cross-section (σ) for absorption of visible light by NO_2 molecules. The value of σ (of the order of 10^{-21} cm^2) was found as a function of the wave number ν between 13 000 and 32 000 cm^{-1} and the absolute temperature T up to 7000°K. The dependence $\sigma(\nu, T)$ was calculated by fitting unknown parameters of the molecule to the experimental absorption curve corresponding to transitions from the vibrational ground level. These parameters were found using the large shift of the normal coordinates of NO_2 between the ground and excited electron states, The author shows that, for a certain set of parameters, absorption can be considered to be due to a one-dimensional oscillator. A.Tybulewicz

539.19 : 535.33

1525 THE EMISSION SPECTRUM FROM QUARTZ VAPOUR.

A.Lau.

Exper. Tech. der Phys., Vol. 7, No. 3, 104-17 (1959). In German.

Bands in the range 2500-4500 A are excited by a h.f. discharge in a heated source and photographed. Wavelengths and approximate intensities are tabulated. For the band system in the ultraviolet the wavelengths are compared with values calculated for the $^1\Pi$ - $^1\Sigma$ transition of SiO. G.F.Lothian

539.19

1526 $3\nu_3$ BAND OF $C^{12}S^{32}S^{34}$.

A.H.Guenther.

J. chem. Phys., Vol. 31, No. 4, 1095-9 (Oct., 1959).

The $3\nu_3$ band of $C^{12}S^{32}S^{34}$ at 4556.553 cm^{-1} was investigated. The following molecular constants, expressed in cm^{-1}, were obtained: $B' + B'' = 0.20970_2$, $B' - B'' = -0.00207_3$, $D' = D'' = 4B^3/\omega_1^2 = = 1.12 \times 10^{-8}$, $\alpha_3 = 0.00069_1$, $\nu_0 = 4556.553$, $r_0 = 1.554_4 \times 10^{-8}$ cm. It is believed that this is the first resolution and analysis of the rotational structure of $C^{12}S^{32}S^{34}$ in the infrared region. When the results of this investigation are compared to those of ordinary carbon disulphide, $C^{12}S_2^{32}$, they are found to be consistent with the relations governing the effect of isotopic substitution on the molecular constants. The value for the internuclear distance, $r_0 = 1.554_4$ A, is in good agreement with the value obtained for ordinary CS_2, i.e., $r_0 = 1.554_5$ A.

539.19

1527 THE SPECTRUM OF IODINE EXCITED IN THE PRESENCE OF ARGON.

R.D.Verma.

Proc. Indian Acad. Sci. A, Vol. 48, No. 4, 197-226 (Oct., 1958).

The band systems of iodine in the regions 3455-3015 A, 2785-2750 A and 2730-2520 A obtained by earlier workers using prism spectrographs are photographed in the first and second orders of a 21 ft grating spectrograph. A large number of new bands are obtained in all these three systems which are extended to the regions 3461-3015 A, 2785-2731 A and 2729-2486 A. The wavelengths and wavenumbers of all the bands are recorded along with their visually estimated intensities. The Deslandres schemes for the three systems representing all the bands are given and are found to be supported by the corresponding intensity distributions of the expected type. It was found that the two systems 3460-3015 A and 2785-2731 A do not involve for their lower levels the ground state as assumed by the earlier workers but the $^3\Pi_u$ (O_u^+) state at 15 642 cm^{-1}, which is also the lower state for the 4420-4000 A system. The band system in the region 2730-2486 A has for its lower level the ground state of the molecule as reported by the earlier workers. A re-analysis of this system made to include all the bands observed in the present experiments, gave vibrational constants slightly different from those obtained by earlier workers. The vibrational constants of the upper states of the four different systems that one gets by exciting iodine in the presence of argon are

System	T_e	ω_e	$\omega_e x_e$	$\omega_e y_e$
4400-4000 A	41411 cm^{-1}	102.2 cm^{-1}	0.34 cm^{-1}	
3460-3015 A	45937 "	103.7 "	0.095 "	
2785-2731 A	51847 "	112.4 "	0.711 "	0.004 cm^{-1}
2730-2486 A	47207 "	96.5 "	0.510 "	0.0033 "

It was found that the 3460-3015 A, 2785-2731 A and 4420-4000 A systems of iodine are respectively analogous to the 2950-2670 A, 2660-2590 A and 3150-2970 A systems of bromine.

539.19

1528 MICROWAVE SPECTRUM AND INTERNAL ROTATION OF 1-CHLORO-2-BUTYNE.

V.W.Laurie and D.R.Lide,Jr.

J. chem. Phys., Vol. 31, No. 4, 939-43 (Oct., 1959).

The microwave spectrum of $CH_3C{\equiv}CCH_2Cl$ was investigated in the region 20-30 kMc/s. The existence of nearly free internal rotation gives rise to regions of very dense absorption. Transitions of the type $\Delta J = 1$, $\Delta K = 0$ were identified for the ground torsional state (m = 0). The ground state spectrum is that of an effective rigid rotor with the rotational constants modified by the internal rotation. Values for the effective rotational constants are 17 631, 1490.55, 1385.06 Mc/s for the Cl^{35} species; and 17329, 1459.76, 1357.26 Mc/s for the Cl^{37} species. These rotational constants permit an upper bound of 100 cal/mole to be established for the barrier to internal rotation. A structural analysis indicates that the CCl bond is longer than in CH_3Cl.

539.19

1529 SOLVENT EFFECTS IN INFRA-RED SPECTROSCOPY.

A.D.Buckingham.

Proc. Roy. Soc. A, Vol. 248, 169-82 (Nov. 11, 1958).

The effects of solute—solvent interactions on the vibrational spectrum of a dissolved molecule are evaluated by supposing that the interaction energy U can be expanded as a power series in the normal co-ordinates of the active molecule. By treating U and the anharmonic terms in the potential energy function of the free molecule as small perturbations to the harmonic oscillator Hamiltonian the solvent shifts, $\Delta\omega$, in the vibrational frequencies are found to be proportional to $(U' - 3U'\mathscr{A}/\omega_e)$, where U' and U' are the first and second derivatives of U with respect to the normal coordinates and $\mathscr{A}/\omega_e$ is an anharmonic constant obtainable from the spectrum of the gas. The theory indicates that $\Delta\omega/\omega$ is independent of isotopic substitution as well as of the order of the transition; experimental data for HCl and DCl support these conclusions. The intensities of vibrational bands of dissolved molecules are shown to be proportional to a factor involving the refractive index of the solvent and to be dependent upon the derivatives with respect to the normal coordinates of the dipole moment of the solute molecule and its near neighbours. It is predicted that for diatomic molecules the intensity of the (n−1)th overtone, $(A_s)_{0,n}$, is related to the frequency ω so that $(A_s)_{0,n}/\omega^{n+1}$ is independent of isotopic substitution, as in the gas phase.

539.19 : 535.33

1530 NEAR INFRA-RED SYSTEM OF NITROGEN.

P.K.Carroll and H.R.Rubalcava.

Nature (London), Vol. 184, 119-20 (July 11, 1959).

A preliminary analysis is given of the 8265.5 A band system, the transition being identified as $^3\Sigma_u^- \rightarrow B^3\Pi_g$. P.A.Young

539.19

1531 A MODIFIED METHOD FOR CALCULATING THE INTENSITIES AND POLARIZATIONS IN THE INFRARED ABSORPTION SPECTRA OF POLYATOMIC MOLECULES.

L.A.Gribov.

Dokl. Akad. Nauk SSSR, Vol. 127. No. 4, 788-91 (Aug. 1, 1959).
In Russian.

The intensities and polarizations were calculated using a method which is simpler than the earlier ones. The derived formula is of a convenient form for use on an electronic computer.

Z.Krasucki

539.19

1532 INFRARED SPECTRA OF TRIMETHYLBORANE-d_9 AND TRIETHYLBORANE-d_{15}.

W.J.Lehmann, C.O.Wilson, Jr, and I.Shapiro.

J. chem. Phys., Vol. 31, No. 4, 1071-5 (Oct., 1959).

For previous work see Abstr. 4377-8 (1958). The infrared spectra of $B(CD_3)_3$ and $B(C_2D_5)_3$ are reported in the range 2 to 15 μ. After minor revisions of a previous frequency assignment for $B(CH_3)_3$, the force constants obtained from a modified valence force treatment of $B(CH_3)_3$ were used to calculate and assign the frequencies of $B(CD_3)_3$. This assignment is consistent with frequency values predicted from a study of other methyl-deuterated compounds. Agreement with the Teller—Redlich product rule is fair. An interesting and perhaps unexpected feature is the upward shift of the B—C asymmetric stretching frequency upon deuteration; the correctness of the assignment of that vibration was verified by use of $B^{10}(CD_3)_3$. The observed bands of $B(C_2D_5)_3$ are assigned.

539.19 : 539.18

1533 EXPERIMENTAL STUDY AT VERY HIGH PRESSURES, OF THE PERTURBATION OF THE VISIBLE AND ULTRAVIOLET ABSORPTION SPECTRUM OF OXYGEN, OF NITRIC OXIDE AND OF THE RESONANCE LINES OF CERTAIN METALS.

J.Robin.
J. Rech. Cent. Nat. Rech. Sci., No. 47, 89-140 (June, 1959).
In French.

Detailed description of several designs of cell to withstand pressures up to 6000 atmospheres, with either external or internal heating; cells are filled while cooled and the pressure obtained by heating. Measurements on the resonance lines of K, Rb, Cs, Tl and Hg as perturbed by increasing pressures of A, He, N_2 and H_2 include: (1) displacement of the lines, the direction depending on the component gases and on the spectrum line; in some cases there is a max. displacement at a density near 200 amagats; (2) broadening and asymmetry of the line contour; (3) change of relative intensity of the components of a doublet; (4) appearance of a nearby "satellite" line. These effects are not adequately explained by existing theories of collisions or perturbing fields. The broadening and change of maximum and total intensity of some lines of O_2 and NO with pressure is also described. Other work is reviewed; 212 references.

G.F.Lothian

539.19

1534 GROUND STATE Λ-DOUBLING TRANSITIONS OF OH RADICAL.

G.Ehrenstein, C.H.Townes and M.J.Stevenson.
Phys. Rev. Letters, Vol. 3, No. 1, 40-1 (July 1, 1959).

The F = 2 → F = 2 and F = 1 → F = 1 transitions between the Λ-doubling levels of the lowest rotational state of the $^2\Pi_{3/2}$ electronic state of the OH radical, whose presence in interstellar space may be detectable by these lines in its radiofrequency spectrum, have been observed in the laboratory.

E.F.W.Seymour

539.19

1535 ON THE TRAPPING OF FREE RADICALS OF OXYGEN AND CHLORINE. S.W.Benson and K.H.Anderson.

J. chem. Phys., Vol. 31, No. 4, 1082-5 (Oct., 1959).

Gas mixtures of Cl_2 ($\sim$ 2 mm Hg) and O_2 ($\sim$ 50 mm Hg), when exposed to light in the near ultraviolet and then trapped at liquid N_2 temperatures, yield a solid Cl_2 matrix, which on warming to room temperature liberates small quantities of O_2 in excess of that trapped mechanically in the absence of light. It is shown that this excess O_2 can be reasonably accounted for in terms of the formation of ClO, Cl_2O_2, or ClOO. Under the experimental conditions the gas-phase concentration of ClO and Cl are about equal, while Cl·OO/Cl is small. If the source of O_2 is Cl·OO it must arise from reaction between Cl and O_2 at the cold walls, the gas phase concentration of Cl·OO being negligible. Very small amounts of Cl_2O and OClO may be formed in the present system, but these would not produce O_2 on warming. Analysis of the flash photolysis experiments on Cl_2—O_2 mixtures indicates that measurable amounts of OClO would be formed unless there was a very rapid isomerization reaction, ClO + OClO → Cl·OO + ClO. The absence of Cl_2O in the flash experiments can be shown to imply a very rapid reaction, $Cl + Cl_2O \rightarrow Cl_2 + ClO$, with an activation energy of less than 4 kcal.

SOLID-STATE PHYSICS

539.2

1536 NEW QUANTUM-MECHANICAL REPRESENTATION.

E.C.McIrvine and A.W.Overhauser.
Phys. Rev., Vol. 115, No. 6, 1531-6 (Sept. 15, 1959).

The superlattice representation is described. This representation provides occupation probabilities which form a well-defined non-negative analogue of the phase space density. The superlattice basis functions are orthonormal wave packets characterized in general by three parameters: a band index, a wave vector, and a superlattice position vector. The crystal momentum and position are automatically coarse-grained so as to satisfy the Heisenberg uncertainty principle. The Bloch and Wannier representations are special cases of the superlattice representation for particular choices of the superlattice parameter. Joint functions of position and momentum, such as the local current density, can be represented as the expectation value of Hermitian operators through the use of this representation. (See also following abstract).

539.2

1537 QUANTUM-MECHANICAL APPROACH TO THERMAL TRANSPORT PHENOMENA IN METALS. E.C.McIrvine.

Phys. Rev., Vol. 115, No. 6, 1537-45 (Sept. 15, 1959).

A quantum-mechanical transport equation corresponding to the classical Boltzmann equation is developed. Classical transport theory in the presence of a temperature gradient involves the phase space density, which has no meaning in quantum mechanics due to the complementarity of position and momentum. The superlattice representation allows the development of a quantum transport equation from the density matrix Schrödinger equation, through the introduction of irreversibility by standard methods. The quantum transport equation governing the electron occupation probability in the superlattice representation is derived for impurity scattering and for phonon scattering. This equation has the same field terms as the classical Boltzmann equation, but involves the discrete coarse-grained wave number and position of the superlattice representation. The scattering terms involve transitions between different superlattice states, and thus include scattering processes which move electrons from one superlattice cell to another. The solution of the classical equation is affected very little by these quantum effects, for all temperature gradients which might reasonably be encountered.

539.2 : 539.19

1538 NEW METHOD FOR CALCULATING WAVE FUNCTIONS IN CRYSTALS AND MOLECULES.

J.C.Phillips and L.Kleinman.
Phys. Rev., Vol. 116, No. 2, 287-94 (Oct. 15, 1959).

For metals and semiconductors the calculation of crystal wave-functions is simplest in a plane wave representation. However, in order to obtain rapid convergence it is necessary that the valence electron wave-functions be made orthogonal to the core wave functions. Herring satisfied this requirement by choosing as basis functions "orthogonalized plane waves." It is here shown that advantage can be taken of crystal symmetry to construct wave-functions φ_α which are best described as the smooth part of symmetrized Bloch functions. The wave equation satisfied by φ_α contains an additional term of simple character which corresponds to the usual complicated orthogonalization terms and has a simple physical interpretation as an effective repulsive potential. Qualitative estimates of this potential in analytic form are presented. Several examples are worked out which display the cancellation between attractive and repulsive potentials in the core region which is responsible for rapid convergence of orthogonalized plane wave calculations for s states; the slower convergence of p states is also explained. The formalism developed here can also be regarded as a rigorous formulation of the "empirical potential" approach within the one-electron framework; the present results are compared with previous approaches. The method can be applied equally well to the calculation of wave functions in molecules.

539.2

1539 NOTE CONCERNING THE HOLSTEIN—PRIMAKOFF FORMALISM. Yu.A.Izyumov.

Dokl. Akad. Nauk SSSR, Vol. 125, No. 6, 1227-30 (April 21, 1959).
In Russian.

A magnetically ordered crystal near its ground state has an energy spectrum approximate to that of a slightly non-ideal Bose gas. Mathematically this is equivalent to a transition from spin to Bose operators. The paper is an attempt to establish the connection between them in general form. C.R.S.Manders

539.2

1540 ENERGY LEVELS FOR RARE EARTH IONS SUBJECT BOTH TO EXCHANGE AND CRYSTALLINE FIELDS.

R.L.White and J.P.Andelin, Jr.

Phys. Rev., Vol. 115, No. 6, 1435-9 (Sept. 15, 1959).

The term splitting is calculated for the lowest lying J state of the rare earth ions samarium through ytterbium for the case in which the ions are simultaneously subjected to exchange and crystalline fields of arbitrary relative magnitude. The crystalline field is taken to be cubic and as representing the potential of eight negative ions situated at the corners of a cube. The calculation is carried out for the magnetic axis in the two major (local) crystalline directions, [100] and [111]. The relevance of these calculations to the rare earth iron garnets is discussed.

539.2

1541 SIMPLIFIED LCAO METHOD FOR ZINCBLENDE, WURTZITE, AND MIXED CRYSTAL STRUCTURES.

J.L.Birman.

Phys. Rev., Vol. 115, No. 6, 1493-505 (Sept. 15, 1959).

The tight-binding (LCAO) method is a convenient, if qualitative, way of comparing energy bands in the zincblende (ZB) and wurtzite (Wur) structures. Using this method it is shown that wurtzite states along $\Gamma-\Gamma'$ ("c" direction in the zone) can be obtained by perturbing corresponding zincblende states along $\Gamma-\Lambda$ ([111] zone direction). The perturbation is the difference of crystal potential, $V' = V(ZB)-V(Wur)$, which takes the zincblende structure into the wurtzite and results in a splitting and shifting of these corresponding states. For k perpendicular to these directions the correspondence of k vectors and of states is not so clear, although some comparison can still be made. The discussion of corresponding zincblende and wurtzite states is helpful in understanding the nature of the energy states in in mixed crystals: (wurtzite structure [111] twinned on zincblende), and in faulted crystals: [111] stacking faults. It is shown that barriers (discontinuities in energy surfaces) exist for electron propagation (current) parallel to the "c" axis of a twinned or faulted crystal due to two effects: a symmetry effect and a polar effect. The second effect is simply illustrated for rotation-twinned zincblende. For randomly faulted crystals, band gaps depend on α, the probability of faulting. Quantitative theories of these effects remain to be developed.

539.2

1542 BAND STRUCTURE OF NOBLE METAL ALLOYS: OPTICAL ABSORPTION IN α-BRASSES AT 4.2°K.

M.A.Biondi and J.A.Rayne.

Phys. Rev., Vol. 115, No. 6, 1522-30 (Sept. 15, 1959).

Calorimetric optical absorption measurements at 4.2°K were made on a representative series of α-brasses over the wavelength range 0.23 to 4.0 μ using electropolished bulk specimens. Changes in the absorption spectrum below 6000 A are interpreted in the light of current theories concerning the band structure of noble metal alloys. The variation of the infrared absorptivity with residual resistivity shows that the impurity relaxation time for copper is anisotropic. This anisotropy increases on alloying and suggests that the Fermi surface becomes more distorted with increasing solute concentration.

539.2

1543 THE ENERGY BAND SYMMETRY IN WURTZITE-TYPE CRYSTALS. I. BAND SYMMETRY WITHOUT TAKING INTO ACCOUNT THE SPIN—ORBIT INTERACTION.

E.I.Rashba.

Fiz. tverdogo Tela, Vol. 1, No. 3, 407-21 (March, 1959). In Russian.

Models of space group C_{6v}^4 (in Zachariasen notation) were constructed, a new method of investigating the distribution of points of zero inclination on the $\epsilon(k)$ surface and determining the law of dispersion near the symmetry elements was developed, and a theoretical group analysis of the energy band structure in crystal lattices of the hexagonal ZnS type (in the absence of spin—orbit bonds) was carried out. M.H.Sloboda

539.2 : 537.533

1544 STRUCTURE IN THE ENERGY DISTRIBUTION OF PHOTOELECTRONS FROM K_3Sb AND Cs_3Sb.

E.A.Taft and H.R.Philipp.

Phys. Rev., Vol. 115, No. 6, 1583-6 (Sept. 15, 1959).

The energy distributions of photoelectrons from K_3Sb and Cs_3Sb show structure that is similar in form to structure in the spectral dependence of the optical absorption. One may rationalize this empirical result by saying that both the photoelectric and optical effects arise from structure in the state-density of the valence band. Assuming that the optical absorption involves transitions to the conduction band, a lower limit for the electron affinity of the crystal is 0.6 eV for K_3Sb and 0.4 eV for Cs_3Sb.

539.2

1545 AN ANALYSIS OF THE SOFT X-RAY EMISSION SPECTROSCOPY OF GRAPHITE AND AN APPROPRIATE ELECTRONIC PICTURE OF IT. A.K.Dutta.

Proc. Phys. Soc., Vol. 74, Pt 5, 604-8 (Nov., 1959).

From an analysis of the soft X-ray emission spectra of graphite, it is deduced that the fundamental Brillouin zone of graphite is bounded by two independent sets of planes, the electrons overlapping one such set into the next zone, and that the total band width is about 24(± 3) eV. On comparing these results with the properties of the three Brillouin zones which have been suggested for graphite, namely the 1-, 3- and 4-electron zones, the last is found to be the most suitable. It is also shown that the K-value for the vertical bounding planes of the four-electron zone corresponds to the energy difference between the origin and the first peak of the soft X-ray spectra, and that there is sufficient $\sigma-\pi$ interaction in the C—C bond formation to make the four-electron zone plausible.

539.2 : 530.16

1546 MANY-PARTICLE APPROACH TO THE ONE-ELECTRON PROBLEM IN INSULATORS AND SEMICONDUCTORS. A.Klein.

Phys. Rev., Vol. 115, No. 5, 1136-46 (Sept. 1, 1959).

A formal theory of one-electron states in insulators and semiconductors is developed from a many-particle point of view. The techniques of second quantization are utilized for this purpose in a manner analogous to that introduced recently for the study of Fermi liquids, i.e., by the study of matrix elements of the electron field operator which describe the propagation of particles or holes. Both types of motion are described symmetrically by means of the one-particle Green's function or propagator. The utility of these constructs for the present study derives from the existence of a gap against single-particle excitation. The basic result is that the motion of electrons near the bottom of the conduction band in the presence of external electric and magnetic fields whose spatial variation over one lattice spacing is small and which contain no frequencies comparable with the gap frequency is governed by a simple Schrödinger equation. The latter contains as parameters only the effective mass (as measured in a cyclotron resonance experiment) and the static dielectric constant and magnetic permeability of the solid. The proof, within the restriction of a fixed, perfect lattice, takes into account all many-body effects. A similar theorem obtains for the motion of holes.

539.2

1547 ELECTRON RESONANCE IN STRONGLY IRRADIATED SILVER CHLORIDE. D.Bösnecker and W.Waidelich.

Naturwissenschaften, Vol. 46, No. 21, 598 (1959). In German.

No electron resonance was obtained with unirradiated AgCl powder at room temperature. On irradiation with a Hg quartz lamp to produce a visible amount of photolytic Ag, a sharp electron resonance line was obtained at room temperature, an additional weaker line appeared at 90°K. The resonance lines are due to conduction electrons. J.Franks

539.2

1548 ENERGY LEVELS OF CONDUCTION ELECTRONS IN A MAGNETIC FIELD. Y.Yafet.

Phys. Rev., Vol. 115, No. 5, 1172-6 (Sept. 1, 1959).

The energy levels of an electron in a periodic potential and a constant magnetic field are found as the solutions to a secular determinant when the following approximations are made: (a) the energy band of interest is spherically symmetric and (b) lattice broadening of the levels is neglected. Inclusions of spin-orbit coupling gives the g factor as function of position in the band. Perturbation theory is used to treat the effect on the free energy of small departures of the band from spherical symmetry. (See also Abstr. 1771 of 1960).

539.2

1549 THEORY OF BLOCH ELECTRONS IN A MAGNETIC FIELD: THE EFFECTIVE HAMILTONIAN. W.Kohn.

Phys. Rev., Vol. 115, No. 6, 1460-78 (Sept. 15, 1959).

The Hamiltonian of a Bloch electron in a static magnetic field is $H = \frac{1}{2}P^2 + V(r)$, where $V(r)$ is the periodic potential, $P = p + A/c$, and A is the vector potential giving rise to the magnetic field $\mathcal{H}$. We consider the case of a nondegenerate band m. It is then shown that, with an error vanishing with $\mathcal{H}$ like $\mathcal{H}^{N+1}$ (N arbitrary), the eigenstates of H can be calculated from an equivalent Hamiltonian $\bar{H}_m(P)$ with the following properties: (1) It is a one-band Hamiltonian, obtained by transforming away all relevant interband matrix elements. (2) It depends only on the gauge-covariant operators P^{α}. (3) It has the periodicity property $\bar{H}_m(P + K) = \bar{H}_m(P)$, where K is an arbitrary reciprocal lattice vector. (4) It can be written as a series $\bar{H}_m(P) = \Sigma_{i=0}{}^N s^i \bar{H}_{m;i}(P)$ where $s \equiv \mathcal{H}/c$ and the functions $H_{m;i}(P)$ are completely symmetrized in the noncommuting operators P^{α}. Properties (3) and (4) can also be summarized in the equations $\bar{H}_m(P) = \Sigma_l a^{(l)} \times \exp[iR^{(l)} \cdot P]$, where the $R^{(l)}$ are lattice vectors and the $a^{(l)}$ can be expanded as $a^{(l)} = \Sigma_{i=0}{}^N s^i a_i{}^{(l)}$. An algorithm is given for the construction of the $\bar{H}_{m;i}$ and carried through for i=0, 1, 2. The formalism is not restricted to the neighbourhood of the bottom and top of the band. It is considered that the equivalent Hamiltonian $\bar{H}_m(P)$ provides a sound basis for a discussion of wavefunctions and energy levels of Bloch electrons in a magnetic field.

539.2

1550 THEORETICAL MODEL FOR TETRAGONAL-TO-CUBIC PHASE TRANSFORMATIONS IN TRANSITION METAL SPINELS. P.J.Wojtowicz.

Phys. Rev., Vol. 116, No. 1, 32-45 (Oct. 1, 1959).

The origin of the large tetragonal distortions which occur in a number of transition metal oxides having the spinel structure has been examined by Dunitz and Orgel [J. Phys. Chem. Solids, Vol. 3, 20 (1957)] in terms of the crystal field theory. According to these authors the macroscopic distortions arise as a consequence of a Jahn–Teller type distortion in the immediate environment of certain transition metal ions. Thus, all the observed large distortions in spinels have been correlated with the results of this crystal field treatment on the basis of the spatial ordering of the local distortions. Here the author investigates the detailed properties of the transformations from tetragonal to cubic phases which are observed at elevated temperatures. An approximate model is constructed which explicitly takes into account the interactions between local Jahn–Teller distortions about neighboring octahedral site cations. The configurational energy of the model is derived in a completely general form in terms of occupation variables, and is used to deduce the structure of the stable low-temperature phase. By the use of the usual methods of statistical mechanics it is proved possible to derive the thermodynamic behaviour of the model, and hence to contribute to an understanding of the cooperative nature of these phase transformations. The temperature and composition dependence of the long-range order parameter, the thermodynamic functions, and the lattice parameters are calculated explicitly. The principal result of importance is the demonstration that the transformations from tetragonal to cubic spinel phases are thermodynamic transitions of the first order type. That is, a latent heat, a volume discontinuity, lattice parameter discontinuities, and a lambda anomaly in the heat capacity are to be observed at the transformation temperature. The available experimental evidence supports the conclusions drawn from the theoretical model. The agreement between theory and experiment is found to be semi-quantitative in most of the cases considered.

Lattice Dynamics

539.2

1551 NATURE OF THE SINGULARITIES IN THE SPECTRUM OF A ONE-DIMENSIONAL IONIC LATTICE. J.Gillis and G.Weiss.

Phys. Rev., Vol. 115, No. 6, 1520-21 (Sept. 15, 1959).

It is known, by a theorem of van Hove, that regular lattices will have singularities in their frequency spectra, the type of singularity depending on the dimension. Although several studies of the one-dimensional lattice with Coulomb interactions have appeared, no one yet has succeeded in identifying the type of singularity that appears, in addition to the inverse square root singularity, in the frequency spectrum. Here it is established that for a one-dimensional crystal the singularity is of the form

$$g(\omega) \sim A\{(\omega-\omega_1) \times \ln[1/(\omega-\omega_1)]\}^{-\frac{1}{2}}$$

where A is a constant and ω_1 is the position of the singularity.

539.2

1552 VIBRATIONAL SPECTRUM OF VANADIUM. D.N.Singh and W.A.Bowers.

Phys. Rev., Vol. 116, No. 2, 279-80 (Oct. 15, 1959).

A theoretical lattice vibration spectrum is calculated, in order to compare with the spectrum measured by the elastic incoherent scattering of neutrons (Abstr. 6400 of 1958; 775 of 1959). The calculated spectrum shows three peaks, the upper two of which occur at frequencies agreeing with the frequencies of the two peaks in the experimental curve. The third peak is not present in the measured spectrum. The maximum frequency of the calculated spectrum is lower by about 15% than the measured value.

539.2

1553 THEORY OF SURFACE MODES OF VIBRATION IN TWO- AND THREE-DIMENSIONAL CRYSTAL LATTICES. R.F.Wallis.

Phys. Rev., Vol. 116, No. 2, 302-8 (Oct. 15, 1959).

For previous work see Abstr. 4865 of 1957. Theoretical expressions are developed for the frequencies and displacements of the normal modes of vibration for two- and three-dimensional alternating diatomic lattices with free boundaries. Only square and cubic lattices are considered. Nearest-neighbour Hooke's law forces having both longitudinal and transverse components are assumed. The results were obtained both by a perturbation method in which the ratio of the transverse and longitudinal force constants is treated as a small quantity and by a Green's function method. The use of the free-boundary condition leads to the existence of surface modes of vibration in which the displacement amplitude is relatively large for a light atom on a boundary and decreases roughly exponentially toward the interior of the lattice. A band of surface mode frequencies lies in the "forbidden" gap between the acoustical and optical branches.

539.2

1554 EFFECT OF LATTICE VIBRATIONAL SPECTRUM ON INTRINSIC ELECTRICAL AND THERMAL RESISTIVITY OF METALS. A.Meyer.

Phys. Rev., Vol. 116, No. 2, 339-41 (Oct. 15, 1959).

The primary purpose of this calculation is to develop a method for incorporating recently calculated lattice vibrational spectra (Abstr. 7811 of 1956) into the present theory of transport properties of metals. A secondary objective is incorporating into the calculation all of the well-known contributions to the electron-phonon part of electrical and thermal resistivities. Included are Umklapp processes, electron-transverse wave interactions, and the Bardeen scattering probability. A final objective of the study is to determine qualitatively the effect of this calculation on the agreement between theory and experiment. The results indicate an appreciable change in the theoretical predictions, the general trend being in the right direction. The relative importance of details of the phonon system versus details of the electron system is greatest for electrical resistivity, intermediate for thermal resistivity, and least for thermoelectric power. For this reason, the results of this calculation, as might be expected, are most significant for electrical resistivity, of some importance still in thermal resistivity, and inadequate for thermoelectric power.

539.2

1555 ANHARMONIC FORCES AND THE EINSTEIN MODEL OF A CRYSTAL. J.W.Leech.

Canad. J. Phys. Vol. 37, No. 9, 1067-9 (Sept., 1959).

The Einstein model is shown to be inaccurate when used to calculate the effect of anharmonic forces on the specific heat of a one-dimensional crystal. It is suggested that the result indicates the need for caution when dealing with the three-dimensional case.

J.W.Leech

539.2

1556 PROPERTIES OF ALKALI HALIDE CRYSTALS AT LOW TEMPERATURES. T.H.K.Barron and J.A.Morrison.

Phys. Rev., Vol. 115, No. 6, 1439-41 (Sept. 15, 1959).

Recent experimental results on low-temperature heat capacities and elastic constants of alkali halide crystals are examined for evidence of anharmonic contributions. It is concluded that if such effects are present their contribution to the characteristic temperature at 0°K is less than that of uncertainties in the experimental results.

539.2 : 536.63

1557 SPECIFIC HEAT OF SOME SEMICONDUCTORS.

P.V.Gul'myayev and A.V.Petrov.

Fiz. tverdogo Tela, Vol. 1, No. 3, 368-72 (March, 1959). In Russian.

Specific heat and Debye temperature were determined for p- and n-Ge, Si, Ag_2S, Ag_2Te, HgSe, InSb and Bi_2Te_3 at various temperatures between 80° and 300°K, and for Cu_2Se, Cu_2Te, ZnSe, SnSe, SnTe, CdSe, CdTe, HgS, CdSb, ZnSb, GaSb, AlSb, Sb_2Se_3, Sb_2Te_3 and Bi_2Se_3 at 80°K. M.H.Sloboda

539.2 : 536.63

1558 SPECIFIC HEAT OF HIGH PURITY IRON BY A PULSE HEATING METHOD.

D.C.Wallace, P.H.Sidles and G.C.Danielson.

J. appl. Phys., Vol. 31, No. 1, 168-76 (Jan., 1960).

A dynamic pulse-heating method has been developed for measuring with an error of less than 2% the specific heats of metal wires from room temperature to 1000°C. The method consists essentially of recording the resistance of the sample wire while it is being heated by a pulse of large current and short time duration; then obtaining the temperature of the wire throughout the pulse with the aid of the measured resistance as a function of temperature; and finally computing the specific heat of the sample from the temperature as a function of time during the pulse, the measured power input to the wire, and the theoretically computed heat loss corrections. Results are given for high-purity iron over the temperature range 25° to 1050°C. Variations of the specific heat near the phase transitions are shown in detail.

539.2 : 536.63

1559 LOW-TEMPERATURE HEAT CAPACITY OF AZURITE.

H.Forstat, G.Taylor and B.R.King.

J. chem. Phys., Vol. 31, No. 4, 929-31 (Oct., 1959).

The heat capacity of azurite, $Cu_3(CO_3)_2(OH)_2$, was measured in the temperature range 1.7-3.6°K. The characteristic λ-type heat capacity anomaly associated with the antiferromagnetic—paramagnetic transition in the crystal (Abstr. 2504 of 1959) was observed, the Néel point being 1.84°K. The entropy change associated with this transition was found to be 1.17 cal/deg mole and agrees fairly well with the theoretical value of 1.38 cal/deg mole calculated from R ln (2S + 1). The contribution to this entropy change above the Néel temperature was approximately 35%, which indicates a comparatively slow diminution of the short-range ordering of the Cu^{++} spins.

539.2

1560 RESULTS OF INVESTIGATIONS AT LOW TEMPERATURES. XXI. ATOMIC AND ELECTRON HEAT OF RUTHENIUM BETWEEN 10 AND 273°K.

K.Clusius and U.Piesbergen.

Z. Naturforsch., Vol. 14a, No. 1, 23-7 (Jan., 1959). In German.

For earlier work, see Abstr. 2840 (1956), 3389-90 (1959), and for Pt XX, see Helvetica Chimica Acta, Vol. 41, 1342 (1958). The atomic heat C_p is measured on a 100 g cylinder. The standard entropy at 25°C, graphically determined, is 6.82 ± 0.05 cal/degree gram atom. Below 22°K the atomic heat can be represented as the sum of lattice heat and electron heat by $C_V = 464.5\ (T/505)^3 + 6.2 \times 10^{-4}T$. The electron heat also manifests itself above 100°K by a decrease in the θ-values. This temperature dependence disappears if one assumes an electron heat of $6.7 \times 10^{-4}T$. One can then represent the lattice heat by a constant Debye temperature of 382°. H.London

539.2

1561 RESULTS OF INVESTIGATIONS AT LOW TEMPERATURES. XXIII. ATOMIC AND ELECTRON HEATS OF MOLYBDENUM AND TUNGSTEN BETWEEN 10°K AND 273°K.

K.Clusius and P.Franzosini.

Z. Naturforsch., Vol. 14a, No. 2, 99-105 (Feb., 1959). In German.

For previous work, see preceding abstract. These are measured on compact specimens of 99.99% purity. The results for Mo and W are respectively as follows. Standard entropy at 25°C: 6.83 and 7.83 cal/degree gram atom. Below 15°K, the electron heats are $5 \times 10^{-4}T$ and 2.7×10^{-4} cal/degree gram atom and the lattice heats are represented by a Debye θ of 454° and 380°. Above 100°K, the lattice heats can also be accounted for by a constant θ of 383° and 320°, if one ascribes $6.5 \times 10^{-4}T$ and $4.9 \times 10^{-4}T$ cal/degree gram atom to the electrons. H.London

539.2 : 539.18

1562 RESULTS OF INVESTIGATIONS AT LOW TEMPERATURES. XXIV. COMPARISON OF THE MOLAR-, TRANSITION- AND MELTING-HEAT AND OF THE ENTROPIES OF THE CONDENSED ISOTOPES N_2^{14} AND N_2^{15}.

K.Clusius, A.Sperandio and U.Piesbergen.

Z. Naturforsch., Vol. 14a, No. 9, 793-801 (Sept., 1959). In German.

5 litres of high purity heavy nitrogen N_2^{15} containing 99.0 at.% N^{15} were made in a thermal diffusion plant. The following caloric properties are compared with those of N_2^{14}: θ (Debye) at 10°K (solid); transition temperature; heat of transition; melting point; heat of melting; boiling point; heat of evaporation; calorimetric entropy at 25°C; statistically calculated entropy at 25°C. The caloric entropies of the ideal gas derived from the measurements agree with the statistical values within better than 0.03 cal/mol degree if the nuclear spin entropy is not taken account of. For the mixed molecule $N^{14}N^{15}$ a zero point entropy R ln 2 is to be expected. This, as well as the nuclear spin entropies, will possibly give rise to anomalies of the specific heat below 1°K. H.London

539.2

1563 DYNAMIC DISPLACEMENTS OF ATOMS AND COEFFICIENTS OF LINEAR EXPANSION OF THE ARSENIDES OF ALUMINIUM, GALLIUM AND INDIUM.

N.N.Sirota and Yu.I.Pashintsev.

Dokl. Akad. Nauk SSSR, Vol. 127, No. 3, 609-11 (July 21, 1959). In Russian.

The characteristic temperatures, the mean square displacements of the atoms obtained from the Debye—Waller theory, and the thermal expansion coefficients, all derived from X-ray measurements, are tabulated over a number of temperature intervals for AlAs (291-577°K), GaAs (78-680°K) and InAs (78-673°K). A plot of mean square displacement against the square of the expansion coefficient gives straight lines for all three substances. R.F.S.Hearmon

539.2 : 536.41

1564 THERMAL EXPANSION COEFFICIENTS OF MANGANESE FLUORIDE. D.F.Gibbons.

Phys. Rev., Vol. 115, No. 5, 1194-5 (Sept. 1, 1959).

The expansivity $(\Delta l/l_{273.2})$ and linear thermal expansion coefficient $[l^{-1}(dl/dT)p]$ were measured for the a and c axes. There is a marked anomaly in the linear thermal expansion coefficients at the Neel temperature; the Neel temperature was found to be 67° ± 1°K. The anomaly has the characteristic shape associated with order—disorder transformations.

539.2 : 537.2

CRYSTAL STABILITY AND THE THEORY OF FERROELECTRICITY. See Abstr. 1565

539.2

1565 CRYSTAL STABILITY AND THE THEORY OF FERROELECTRICITY. W.Cochran.

Phys. Rev. Letters, Vol. 3, No. 9, 412-14 (Nov. 1, 1959).

The condition for a ferroelectric transition appears to be a problem in lattice dynamics, the transition being associated with the instability which arises when the frequency of one of the modes of vibration approaches zero. It is shown that a diatomic cubic crystal can exhibit properties remarkably similar to those of barium titanate, and the expression for the free energy is similar to that postulated by Devonshire. The theory has been extended to include ferroelectric cubic crystals, and shows that one of the modes of vibration in barium titanate should reach an abnormally low value ~ 10^{11} c/s near the Curie temperature, and should split appreciably in the tetragonal phase. R.C.Kell

539.2

1566 ON MAGNETO-ACOUSTIC RESONANCE IN METALS.

N.Mikoshiba.

J. Phys. Soc. Japan, Vol. 13, No. 7, 759 (July, 1958).

Pippard's suggestion for low frequency resonance ($\omega\tau \ll 1$, where ω is the angular frequency of the acoustic waves and τ the electron relaxation time) is discussed. A new high frequency resonance condition is suggested for longitudinal waves in a transverse magnetic field; this will occur when the phonon energy is equal to the energy gap induced by the field between quantized electron states. The appropriate frequency will be ~ 10^{11} sec^{-1} for metals and ~ 10^9 sec^{-1} for semiconductors. M.G.Priestley

539.2 : 534.22

1567 DISPERSION OF SOUND IN METALS IN A MAGNETIC FIELD. A.A.Galkin and A.P.Korolyuk.

Zh. eksper. teor. Fiz., Vol. 34, No. 4, 1025-6 (April, 1958).
In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 34(7), No. 4, 708-9 (Oct. 1958).

By comparing the phase of 7 Mc/s ultrasonic waves transmitted through samples of tin and aluminium at room temperature with the phase of the ultrasonic generator, small changes in velocity (of a few parts in 10^6) were observed when a magnetic field was applied to the specimen and were found to be proportional to the square of the field. This result, and the magnitude of the effect, agree with the prediction of Alpher and Rubin (Abstr. 7193 of 1954); so also does a failure to observe any similar effect in bismuth.

L.Mackinnon

539.2 : 534.23

1568 LOW-TEMPERATURE ULTRASONIC ATTENUATION IN TIN AND ALUMINUM. D.H.Filson.

Phys. Rev., Vol. 115, No. 6, 1516-19 (Sept. 15, 1959).

According to theory based on an ideal metal, the ultrasonic attenuation should be proportional to the square of the frequency and to the electrical conductivity of the metal. Experiments were performed to compare theoretical and experimental values of attenuation in a frequency range from 100 kc/s to 1 Mc/s. A long wire sample coupled to a barium titanate transducer was suspended in a chamber, which in turn was placed in a liquid helium bath. A short train of sine waves was sent through the wire and the amplitude of successive reflections was measured as a function of temperature and frequency. The electrical conductivity of the sample was also measured. Two samples were investigated. High-purity tin yielded experimental results in excellent agreement with theory. The attenuation in high-purity aluminium was proportional to the electrical conductivity but averaged 45% higher than theoretically predicted. (See also following abstract).

539.2 : 534.23

1569 ACOUSTIC ATTENUATION IN ALUMINUM DUE TO ELECTRON–LATTICE INTERACTION. E.Lax.

Phys. Rev., Vol. 115, No. 6, 1591-5 (Sept. 15, 1959).

The attenuation of sound due to the interaction of electrons with the lattice was measured in pure polycrystalline aluminium at low temperatures. Measurements from 26 to 130 kc/s, obtained by recording the decays of the harmonics of a longitudinally resonating bar, were compared with the electrical conductivity of an aluminium wire of identical purity, over a temperature range of 3° to 70°K. The attenuation was proportional to the square of the frequency. A detailed agreement between the shape of the attenuation and conductivity curves was obtained, but the experimental attenuation was 50% greater than could be explained by the present theory.

539.2

1570 ELECTRON–LATTICE INTERACTION IN METALS. P.G.Harper.

Proc. Phys. Soc., Vol. 74, Pt 5, 545-53 (Nov., 1959).

A solution to the electron–lattice equations of motion is derived which exactly describes resultant harmonic lattice motion. The secular equations admit two alternative solutions: (1) a simple re-normalization of the sound velocity; (2) a re-normalization of the sound velocity accompanied by a displacement of the equilibrium positions of the ion sites, the latter being represented by a static component of the phonon amplitudes. These secular equations are solved and their possible application to the superconducting state briefly discussed.

539.2

1571 CYCLOTRON RESONANCE IN CdAs$_2$. M.J.Stevenson.

Phys. Rev. Letters, Vol. 3, No. 10, 464-6 (Nov. 15, 1959).

Measurements at 2°K and about 22 000 Mc/s indicate that both electrons and holes occupy spheroidal regions with their symmetry axes along the c-axis of the crystal; the effective masses along the c-axis are 0.16 m_0 for electrons and 0.11 m_0 for holes, and perpendicular to the c-axis, 0.57 m_0 for electrons and 0.32 m_0 for holes.

R.G.Chambers

539.2

1572 ENERGY TRANSPORT IN ORGANIC PHOSPHORS. S.C.Ganguly and N.K.Chaudhury.

Rev. mod. Phys., Vol. 31, No. 4, 990-1017 (Oct., 1959).

Reviews are given of various transport processes such as photon reabsorption, collisional exchange, wave mechanical resonance exchange, exciton migration and the motion of electrons and positive holes. Specific attention is given to transfer in mixed organic crystals, to the electronic states of aromatic molecular crystals such as benzene, naphthalene etc., to the effect of crystal size on fluorescence spectra and decay times. Separate sections deal with organic crystals as scintillators and as photoconductors. Insufficiency of experimental data on the various methods of transport is stressed in discussions of distinguishing features between them.

G.F.J.Garlick

539.2

1573 THE ENERGY OF EXCITONS FOR VERY SMALL QUASI-MOMENTA. S.I.Pekar.

Zh. eksper. teor. Fiz., Vol.35, No.2(8), 522-3 (Aug., 1958).
In Russian. English translation in: Soviet Physics–JETP (New York), Vol.35(8), No.2, 360-1 (Feb., 1959).

The crystal wave-function is constructed as a linear combination of antisymmetric products of wave-functions of separate cubic cells (containing a large number of atoms). The exciton energy for small k is evaluated from this wave-functions by standard methods, and is given by $E(k) = E(0) + u(k)$, where $u(k)$ can be interpreted as the electrostatic energy of a dipole at the origin in the field of similar dipoles at the centres of all the other cubes. Although $E(k)$ is a continuous function of k along any direction, it has a discontinuity at $k = 0$. See also Abstr. 1730 (1960).

L.Pincherle

539.2

1574 PERTURBATION THEORETICAL CALCULATION OF THE SELF-ENERGY AND MASS OF THE POLARON.

G.Höhler and A.Müllensiefen.

Z. Phys., Vol.157, No.2, 159-65 (1959). In German.

The perturbation theoretical results for the self-energy and the mass of the polaron are given in 4-th order. Even for a coupling strength usually assumed in NaCl ($g^2 = 6$) the deviations from the values found in Feynman's (Abstr. 3261 of 1955) variational approach are negligible. A remark concerning the approximation character of Feynman's method is made from comparison of the expression for the self-energy.

539.2 : 536.21

1575 LOW TEMPERATURE THERMAL CONDUCTIVITY OF LITHIUM FLUORIDE CRYSTAL UPON IRRADIATION BY THERMAL NEUTRONS AND ^{60}Co γ-RAYS. A.F.Cohen.

Bull. Inst. Internat. Froid, Annex 1958-1, 173-80.

The results indicate that the low temperature thermal resistance after irradiation with doses as low as 4.5×10^{15} neutrons/cm^2, is largely due to clusters of point defects and the thermal resistance passes through a maximum with increasing dose, probably associated with a decrease in the lattice expansion. Similar results are obtained with γ-rays.

J.E.Caffyn

539.2 : 536.21

1576 THERMAL CONDUCTIVITY OF SOLID ARGON AT 80°K. D.J.Lawrence, A.T.Stewart and E.W.Guptill.

Canad. J. Phys., Vol. 37, No. 9, 1069-72 (Sept., 1959).

In the apparatus shown diagrammatically commercial argon was made to flow at a constant rate into a 2.5 cm diameter precision bore glass tube immersed about 26 cm in liquid air. A polycrystalline layer of solid argon of uniform thickness forms on the inside of the tube. The thermal conductivity k was obtained from the slope of the graph of $2\pi h\ \Delta T/\dot{Q}$ against $\ln(r_1/r)$, where $\dot{Q}$ is the radial heat flow; ΔT the temperature difference between the solid argon inner surface and the bath, and h the length and r_1 and r the radii of the argon cylindrical shell. The average value obtained was $k = 2.6 \pm 0.4$ mW cm^{-1} deg^{-1}.

S.Weintroub

539.2 : 536.21

1577 THERMAL CONDUCTIVITY OF CLEAR FUSED SILICA AT HIGH TEMPERATURES. K.L.Wray and T.J.Connolly.

J. appl. Phys., Vol. 30, No. 11, 1702-5 (Nov., 1959).

The conductivity was measured from 300° to 2100°K in an experiment which minimized radiative energy transport. This was a steady-state experiment involving the measurement of the electric current and voltage drop through a fine tungsten wire which was embedded along the axis of a cylindrical silica rod. The wire served both as a heating element and as a resistance thermometer. Thermal conductivities were calculated by graphical evaluation of the rate of change of electric power with temperature at difference temperatures. The experiment yielded thermal conductivities between 2.6×10^{-3} and 2.9×10^{-3} cal/(cm sec deg K) at room temperature, and between 4.5×10^{-3} and 5.5×10^{-3} cal/(cm sec deg K) over the range 1000-2100°K.

539.2 : 536.21

1578 EFFECT OF FISSION RECOIL FRAGMENTS ON THE THERMAL CONDUCTIVITY OF GRAPHITE.

L.P.Hunter.

J.appl. Phys., Vol.30, No.12, 1969-75 (Dec., 1959).

The variation of the thermal conductivity of uranium-impregnated graphite is measured continuously while under neutron irradiation. The temperature is continuously monitored and results are reported which show the effects of the uranium oxide particle size as well as the effect of the neutron bombardment as separated from the fission recoil bombardment.

Defect Properties

539.2

1579 THE MEASUREMENT OF DISLOCATION DENSITIES FROM THE LATTICE HEAT CONDUCTIVITY OF COPPER-ZINC ALLOYS.

J.N.Lomer and H.M.Rosenberg.

Bull. Inst. Internat. Froid, Annexe 1958-1, 181-6.

The density of dislocations N, introduced by deformation, was calculated from the variation in thermal conductivity between 2° and 4.2° K. N increases rapidly during stage 2 of the deformation independent of the Zn content, and reaches a limiting value in stage 3, which depends on the Zn content. Measurements of electrical conductivity during the deformation indicate that stacking faults cause a considerable decrease in conductivity. J.Franks

539.2

1580 ETCHING AS MEANS OF REVEALING DISLOCATIONS IN GERMANIUM AND SILICON.

A.D.Trekhtenberg and S.M.Fainshtein.

Fiz tverdogo Tela, Vol. 1, No. 3, 373-7 (March, 1959). In Russian.

Etching pits were used to reveal the presence, and to determine the density, of dislocations in Ge and Si. The following etching reagents were found to be most effective: (1) KOH 12 g, $K_3Fe(CN)_6$ 8 g, H_2O 100 ml, for (111) and (110) planes in Ge; (2) HF 4 vol. parts, HNO_3 2 vol. parts, H_2O 2 vol. parts, $Cu(NO_3)_2$ 200 mg, for (100) plane in Ge; (3) 40% HF 8-10 vol. parts, 50% HNO_3 10-30 vol. parts, glacial CH_3COOH 10-35 vol. parts, Br 0.06-0.3 vol. parts, for (111), (110) and (100) planes in Si. Photomicrographs (including those made by interference methods and with the aid of electron microscope) of some of the patterns obtained are reproduced. M.H.Sloboda

539.2

1581 THE VOLUME DISTRIBUTION OF LATTICE DEFECTS IN GERMANIUM CRYSTALS IRRADIATED BY FAST ELECTRONS.

L.S.Smirnov and P.A.Glazunov.

Fiz. tverdogo Tela., Vol.1, No.9, 1376-8 (Sept., 1959). In Russian.

Germanium blocks are irradiated by electrons and the distribution of defects determined by measuring conductances along the direction of the beam. It is found that defects are produced by beams of energy 380 keV or more. There is no significant diffusion of defects. Defects produced by beams from 380 to 900 keV all seem to be of the same type. A.E.I. Research Laboratory

539.2

1582 STUDY OF THE DEFECTS OF A CRYSTAL LATTICE BY MEANS OF INTERNAL FRICTION.

V.A.Pavlov.

Fiz. Metallov i Metallovedenie, Vol.6, No.1, 122-7 (1958). In Russian.

Pure Al and an Al—Mg alloy (3% Mg) were studied at low temperatures. Two internal friction peaks were observed over the temperature ranges from -50° to -80°C and from -170° to 180°C, together with an increase of the internal friction in the region of −196°C. The activation energies of the processes responsible for the friction peaks are 0.5 and 0.14 eV, respectively, and for the internal friction increase $\sim$ 0.05 eV. The occurrence of the internal friction peaks can be explained by the diffusion of the lattice defects.

539.2

1583 EFFECT OF BISMUTH ON DISLOCATION DENSITY IN SINGLE CRYSTAL GERMANIUM.

V.G.Alekseeva and P.G.Eliseev.

Fiz. tverdogo Tela, Vol.1, No.8, 1304-7 (Aug., 1959). In Russian.

Dislocations in germanium containing antimony and bismuth are revealed by etching in $K_3[Fe(CN)_6]$ + KOH. Photographs of etched crystals are reproduced and discussed. R.F.S.Hearmon

539.2

1584 DISLOCATIONS IN TWO TYPES OF CdS CRYSTALS.

D.C.Reynolds and S.J.Czyzak.

J. appl. Phys., Vol. 31, No. 1, 94-8 (Jan., 1960).

Dislocation densities in CdS crystals (types I and II) have been investigated employing chemical etching techniques. There is very little difference in the dislocation densities in the two types of CdS crystals. The dislocation density in both types of growth varies over a range from 10^7 to 10^1 per cm^2. However, type I crystals have a greater tendency to twin and low angle boundaries are generally present in the twinned crystal.

539.2

1585 DEFECTS IN DISLOCATIONS PRODUCED BY FOCUSING COLLISIONS IN F.C.C. LATTICES.

G.Leibfried.

J. appl. Phys., Vol. 31, No. 1, 117-21 (Jan., 1960).

It is assumed that a focusing collision of sufficiently high energy encountering a stacking fault area of an extended dislocation produces a Frenkel pair. This effect is thought to be important in radiation damage where primary knock-ons produce long range focusing collisions. The number of Frenkel pairs which are produced this way is calculated. Two effects are discussed in detail for Cu.
(1) The enhancement of damage by enhanced production of Frenkel pairs if dislocations are present. It is shown that one can expect an appreciable enhancement of damage for heavily cold-worked material. (2) The pinning of dislocation motion. If one assumes that each Frenkel pair produced in a dislocation acts as a primary point, the theoretical result is in qualitative agreement with the experimental data on dislocation pinning by irradiation.

539.2

1586 DISLOCATION STRUCTURE AND THE FORMATION AND STRENGTH OF SODIUM CHLORIDE WHISKERS.

W.W.Webb.

J. appl. Phys., Vol. 31, No. 1, 194-206 (Jan., 1960).

Details of dislocation structure have been determined for a variety of NaCl whiskers and microcrystals grown from porous substrates moistened with supersaturated aqueous solution. Some of the smaller needle-like crystals have the single dislocation with an axial screw component usually assumed for whiskers. Larger whiskers and platelets often have much more complicated dislocation structures and may have higher dislocation densities than normal bulk crystals. Strengths were compared with dislocation structures and it was found that the nearly theoretical strengths observed in some of these whiskers are not due to merely a size effect but are directly related to the dislocation structure. Even crystals with high dislocation densities exhibited high strength in bending provided that all of the dislocations were so arrayed that they were not influenced by the applied stress. Regular dislocation arrays often occur naturally with this growth mechanism. However, irregular dislocation structures often associated with growth irregularities invariably resulted in low strength. Techniques for application of X-ray diffraction microscopy to determination of the dislocation structure of microcrystals are described.

539.2

1587 STUDIES OF INDIVIDUAL DISLOCATIONS IN CRYSTALS BY X-RAY DIFFRACTION MICRORADIOGRAPHY.

A.R.Lang.

J.appl. Phys., Vol.30, No.11, 1748-55 (Nov., 1959).

The distribution of imperfections within the interior of crystals has been studied using "projection topographs" which are X-ray diffraction images showing a projection of a slice of crystal and the imperfections in it. Individual dislocations have been observed in single crystals of diamond, silicon, germanium, lithium fluoride, sodium chloride, silver chloride, magnesium oxide, calcite, quartz, and aluminium. From the variation of dislocation contrast with the orientation of the X-ray reflecting plane the direction of Burgers vector can be found. Dislocations can be seen with good contrast when the product of linear absorption coefficient μ and slice thickness t is of the order of unity or less. If $\mu t \gg 1$ the contrast is reversed through the Borrmann effect. Stereo pairs of projection topographs can be prepared from the pair of reflections hkl and $\overline{hkl}$.

539.2

1588 STUDIES OF VACANCIES IN DISLOCATION-FREE Ge CRYSTALS.

A.G.Tweet.

J. appl. Phys., Vol. 30, No. 12, 2002-10 (Dec., 1959).

Dislocation-free Ge crystals of 50 g weight have been grown from the melt by the Dash technique (1958). Cu has been diffused into slabs of these crystals for 0.5 to 2 hr at 700-850° C. Acceptors with an ionization energy indistinguishable from that of the lowest substitutional Cu level were observed. Their concentration ranged from $\sim 0.5 \times 10^{15}$ cm^{-3} for samples taken from the tops of crystals to $\sim 3 \times 10^{15}$ cm^{-3} for samples from near the bottom. Insufficient time was available for the dissociative diffusion of substitutional Cu into the interior from the surface to account for the observed acceptor concentrations. The data may, however, be interpreted as indicating that vacancies trapped into the crystal during normal growth combine with rapidly diffusing interstitial Cu atoms to make substitutional Cu atoms. According to this interpretation, the data show that the concentration of vacancies trapped into the bottom of a dislocation-free Ge crystal is larger than at the top, presumably as a consequence of the heat treatment the crystal receives during normal growth. The vacancy concentration at the melting point is $2.9\text{-}3.9 \times 10^{15}$ cm^{-3}, on this model. Methods of altering the vacancy content of the crystals by further heat treatment are discussed. Some experimental details of Cu diffusion into dislocation-free Ge are given.

539.2

1589 DISLOCATION ARRANGEMENTS IN MOLYBDENUM.

J.F.Kerridge, A.A.Johnson and H.I.Matthews.

Nature (London), Vol. 184, 356-7 (Aug. 1, 1959).

An account of some preliminary results achieved by transmission electron microscopy on the movement of dislocations during deformation and recovery processes in thin Mo foil. J.Thewlis

539.2

1590 RELAXATION OF DISLOCATIONS IN COPPER.

P.G.Bordoni, M.Nuovo and L.Verdini.

Nuovo Cimento, Vol. 14, No. 2, 273-314 (Oct. 16, 1959).

Frequency and attenuation of standing waves were measured in polycrystalline copper in the frequency range between 1.8 kc/s and 6.5 Mc/s as a function of temperature from 60° K to 300° K. Owing to the wide frequency range, the activation energy W and the limiting frequency ω_A associated with the attenuation peak due to dislocations have been evaluated with considerable accuracy. The values obtained ($W = 0.122$ eV (molecule)$^{-1}$, $\omega_A = 23.9 \times 10^{11}$ sec^{-1}) agree satisfactorily with those computed according to the theories given by Seeger, Donth and Pfaff. The shape of the attenuation versus temperature curves shows that the spectrum of relaxation frequencies is a bell-shaped line with its maximum at $\omega = \omega_m$; each frequency of the spectrum is associated with the value of W given above. The height of the attenuation peaks is compared with the total relaxation exhibited by the frequency versus temperature curves. Below 100 kc/s the results agree with the theory of relaxation effects with a continuous spectrum. At higher frequencies the polycrystalline structure gives rise to an attenuation larger than the values that could be expected from the frequency relaxation measurements. The effects of heat treatments have also been investigated, showing that the attenuation and the frequency relaxation are both reduced by treatments whose temperature does not exceed 500° K, whilst ω_A is slightly increased. Treatments at higher temperatures give rise to comparatively large changes in attenuation and frequency, which do not seem directly related to the pre-existing dislocations. These changes are reversible and can be cancelled by a suitable amount of cold work.

539.2

1591 DISLOCATION PINNING IN N-TYPE GERMANIUM.

R.L.Cummerow and A.R.Cherry.

Phys. Rev. Letters, Vol. 3, No. 8, 367-8 (Oct. 15, 1959).

A new type of pinning has been found which depends on the type and extent of doping. Simple bending gives single slip and a well defined neutral region. With 2.8×10^{19} As atoms per cm^3 the neutral region does not change on annealing but with 2.5×10^{19} Ga atoms per cm^3 thermally induced glide is observed and dislocations move into the neutral region. This is explained in terms of the substitutional As atoms forming a fifth valence bond with dangling bonds at the dislocation line. Etches for revealing the dislocations in this highly doped material are given. W.Bardsley

539.2

1592 CLASSICAL, NON-LINEAR LATTICE STATICS OF THE EDGE DISLOCATION. I. THEORY.

F.Wahl.

Z. Naturforsch., Vol. 14a, No. 10, 901-12 (Oct., 1959). In German.

The theory (Abstr. 6267 of 1959) is applied to a model of an edge dislocation, and conditions chosen such that the numerical calculation of the stable positions of the distorted lattice is reduced to a minimum. A monatomic cubic lattice is used as an example; although this lattice is unstable, the main results can be simply deduced. The results are then applied to a stable edge dislocation in an ionic crystal. J.Franks

539.2

1593 FORMATION OF INTERSTITIALS IN ALKALI HALIDES BY IONIZING RADIATION.

R.E.Howard and R.Smoluchowski.

Phys. Rev., Vol. 116, No. 2, 314-15 (Oct. 15, 1959).

Recent experimental evidence (Abstr. 2654, 7525 of 1958) seems to indicate that interstitials in alkali halides are formed by ionizing radiation. The validity of the so-called Varley mechanism (Abstr. 3265, 4180 of 1955) depends on several factors such as the lifetime of the positive halogen ion, lattice geometry, etc. These are evaluated and found favourable.

539.2

1594 OPTICAL DETECTION OF VACANCIES CREATED BY HIGH-ENERGY RADIATION IN SODIUM CHLORIDE.

H.W.Etzel and J.G.Allard.

Phys. Rev., Vol. 116, No. 4, 885-7 (Nov. 15, 1959).

For previous work see Abstr. 1740 of 1956. The presence of vacancies created by high-energy radiation in sodium chloride single crystals was detected by comparing the F-centre coloration produced by ultraviolet light after irradiation and optical bleaching to that obtained before irradiation. The behaviour of the F-centre coloration as a function of time of irradiation under ultraviolet light after exposure of the crystals to high-energy radiation is different for synthetic and natural sodium chloride. This difference is attributed to the presence of hydroxyl ions in the synthetic crystals which are inadvertently introduced into the lattice during the growth of the crystals in air. The results obtained are the same whether 40 kVp X-rays, 2 MeV electrons, or Co^{60} γ rays are used to create the F centres.

539.2 : 537.311

1595 CRYSTALLINE IMPERFECTIONS AND 1/f NOISE.

J.J.Brophy.

Phys. Rev., Vol. 115, No. 5, 1122-5 (Sept. 1, 1959).

The 1/f noise of single-crystal silicon and germanium was examined as a function of naturally occuring imperfection densities, dislocations produced by plastic deformation, and imperfections resulting from fast-neutron irradiation. In all cases the noise power decreases with increasing crystalline imperfection. The results may be quantitatively explained by assuming that 1/f noise is proportional to the square of the minority carrier lifetime and accounting for the decrease in lifetime due to imperfections.

539.2

1596 COLOR CENTERS IN KI:Tl X-RAYED AT LOW TEMPERATURES.

H.Hersh.

J. chem. Phys., Vol.31, No.4, 909-19 (Oct., 1959).

The optical properties of the phosphor KI:Tl were studied after X-ray irradiation at 5 or 78° K. The interactions among the several simultaneously produced centres were studied by following and correlating changes in luminescent intensity and optical absorption spectra as the crystal is warmed, and an explanation of these effects is offered in terms of retrapping and recombination. Perturbation bands due to the modification of the energy levels of the luminescent centre as a result of the interaction with a colour centre are observed. The major centres produced in the more heavily doped crystals by brief irradiation at low temperatures do not involve vacancies and are identified as an electron centre associated with Tl, I_2^-, and V centres near Tl$^+$. The optical spectrum of I_2^- consists of bands at 404 and 800 mμ. The absorption of Br_2^- in KBr:Tl was also identified. On the basis of certain similarities in luminescence properties, essentially similar effects are proposed for ultraviolet as for X-ray excitation.

539.2

1597 AGGREGATION OF F CENTERS IN POTASSIUM IODIDE.

D.H.Goode and P.A.Schroeder.

Phys. Rev., Vol. 115, No. 6, 1426-7 (Sept. 15, 1959).

As optical aggregation of F-centres proceeds in KI the R, M, and N bands develop, but later lose their identity in a very broad band, which is absent in KCl and KBr. The shape and position of this band are temperature independent, and it is removed from the peak of the true colloid band. A new band on the short-wavelength side of the F-band was observed in crystals containing high concentrations of F-centres.

539.2 : 582.27

1598 ELECTRON SPIN RESONANCE OF COLLOID CENTRES IN LITHIUM HYDRIDE.

W.T.Doyle, D.J.E.Ingram and M.J.A. Smith.
Proc. Phys. Soc., Vol. 74, Pt 5, 540-4 (Nov., 1959).

Lithium hydride becomes additively coloured by exposure to ultraviolet light. An optical absorption band is produced at 6500 A. From the position and general behaviour of the absorption band it may be assumed that this is due to colloidal particles comparable in size with the wavelength of visible light. It is supposed that the coloration process follows the Gurney—Mott theory of the photographic process. The irradiated specimens also exhibit a symmetrical, temperature-independent electron spin resonance absorption. This resonance is attributed to conduction electrons in colloidal particles which are small compared with the skin depth at 9000 Mc/s.

539.2

1599 DIFFUSION AND SOLUBILITY OF Ta IN Ge.

A.V.Sandulova and Khe Yui-lyan.
Dokl. Akad. Nauk SSSR, Vol. 128, No. 2, 329-32 (1959). In Russian.

Presents the results of experimental investigation of the coefficient of diffusion, and solubility, of Ta in Ge as functions of temperature and of specific resistance of Ge. The radioactive isotope Ta^{182} was applied to one side of the Ge specimen. It was found that the rate of diffusion of Ta depends on the degree of purity of the Ge monocrystals, and that for polycrystals it can be of the same order of magnitude as for monocrystals of a much poorer degree of purity. The solubility of Ta in Ge (whether of n- or p-type) attains a maximum at 880 ± 3°C. F.Lachman

539.2 : 536.48

SELF-DIFFUSION IN SOLID He^3. See Abstr. 1069

539.2

1600 INVESTIGATION OF SELF-DIFFUSION IN Ag BY THE FINITE SUM METHOD.

S.D.Gertsriken and D.D.Tsitsiliano.
Fiz. Metallov i Metallovedenie, Vol. 6, No. 1, 89-94 (1958). In Russian.

The study was made from 650° to 900°C, using the method of Gertsriken and Lozovik (1956). It was found that

$$D_{Ag} = 1.084 \exp\left(-\frac{44800}{RT}\right) \text{cm}^2/\text{sec},$$

which agrees with other published data. The main advantage of the method is that small diffusion coefficients can be measured relatively quickly.

539.2

1601 DIFFUSION OF OXYGEN IN SILICON.

R.A.Logan and A.J.Peters.
J. appl. Phys., Vol. 30, No. 11, 1627-30 (Nov., 1959).

Oxygen has been diffused into Si at temperatures above 1250°C. The diffused layers have been detected by subjecting the samples to a second heat treatment at 450°C. The donors, which then form from the oxygen, cause the layer to convert to n-type. The relationship between donor and oxygen concentrations was established by studying donor formation in crystals of known oxygen concentration. From these results and the electrical properties of the layers, the diffusivity and solubility of oxygen in silicon has been measured. For silicon, in contact with SiO_2 (glass), the heat of solution is (2.3 ± 0.3) eV and the diffusivity is given by

$$D = 135 \exp(-3.5 \text{ eV}/T).$$

539.2

1602 GRAIN-BOUNDARY DIFFUSION OF ZINC IN COPPER MEASURED BY THE ELECTRON-PROBE MICROANALYZER.

M.R.Achter, L.S.Birks and E.J.Brooks.
J. appl. Phys., Vol.30, No.11, 1825-7 (Nov., 1959).

Grain-boundary and lattice diffusion of zinc vapour into copper at 550°C were measured with the electron-probe microanalyzer and the results were used to calculate the diffusion coefficients. The lattice diffusion coefficient D_L increases from 5×10^{-13} to 3×10^{-11} over the concentration range from 2 to 27.5 atomic percent zinc. Over the same concentration range, the grain boundary diffusion coefficient D_B changes from 1×10^{-7} to 7×10^{-6}. The ratio of grain boundary diffusion coefficient to lattice diffusion D_B/D_L remains at approximately 10^6.

539.2

1603 ANION DIFFUSION IN ALKALI HALIDE CRYSTALS.

A.B.Lidiard.
J. Phys. Chem. Solids, Vol. 6, No. 2-3, 298-300 (Aug., 1958).

Discussion of results obtained by Harrison et al. [Trans. Faraday Soc., Vol. 54, Pt I, 106 (1958)] on the diffusion of Cl in NaCl. Consistent explanation of the observed low temperature diffusion is provided by a model of mobile vacancy pairs.

J.Adam

539.2

1604 ANION DIFFUSION IN DOPED CRYSTALS OF POTASSIUM CHLORIDE.

J.A.Morrison and R.Rudham.
J. Phys. Chem. Solids, Vol. 6, No. 4, 402-4 (Sept., 1958).

Two mechanisms have been proposed for the diffusion of the chloride ion at fairly low temperatures: a vacancy-pair mechanism (Lidiard) requiring a diffusion rate independent of impurity content, and a free vacancy mechanism, which should be very sensitive to the concentration of aliovalent impurity ions. Experiments with pure crystals and crystals doped with cation or anion impurity in the temperature range 330-545°C support Lidiard's mechanism, even though the observed activation energy cannot be accounted for satisfactorily. B.T.M.Willis

539.2

1605 DIFFUSION MEASUREMENTS IN THE SYSTEM Cu—Au BY ELASTIC SCATTERING.

R.F.Sippel.
Phys. Rev., Vol. 115, No. 6, 1441-5 (Sept. 15, 1959).

A broad-range magnetic spectrograph was used to study the diffusion of gold into copper in the temperature range 360-500°C by elastic scattering of protons and deuterons. This is a new technique in solid diffusion measurements and should have fairly wide applicability in intermetallic diffusion. This investigation extends the data a factor of 10^6 below the sectioning range. These results, together with data of sectioning observers, show the Arrhenius law to be approximately valid over a range in D of 5×10^8. A precise fit to all the data requires a slight upward curvature. In the temperature range studied, $Q = 45\,750 \pm 750$ cal/mole and $D_0 = 0.104 \pm 0.6$ cm²/sec. This represents a decrease of about 4000 cal/mole from the most precise data in the sectioning range. This curvature is attributed to diffusion along internal surfaces, although the possibility of multiple diffusion mechanisms still remains.

539.2

1606 TRACER DIFFUSION IN A CHEMICAL CONCENTRATION GRADIENT IN SILVER—CADMIUM.

J.R.Manning.
Phys. Rev., Vol. 116, No. 1, 69-79 (Oct. 1, 1959).

Measurements have been made on seven Ag—αAgCd diffusion couples of the diffusion of a layer of radioactive tracer atoms (either Ag^{110} or Cd^{109}) located originally at the Ag—AgCd interface. It was found that the centre of gravity of the layer of tracer atoms shifted from its original position, marked by tungsten wires. The shapes of the tracer profiles for Ag^{110} were quite different from those for Cd^{109}. However, for both silver and cadmium tracer, the centre of gravity moved toward the cadmium-rich region. A theoretically predicted shift in centre of gravity is obtained, taking into consideration the fact that the diffusion coefficient, correlation factor, and chemical potential are functions of chemical composition. The predicted shift in centre of gravity arising from the flow of imperfections and the lattice distortion associated with the Kirkendall shift also are considered. Good agreement is found between theory and experiment. Chemical interdiffusion and Kirkendall shift measurements were consistent, within errors, with those predicted by Darken [Transactions of the American Institute of Mining and Metallurgical Engineers, Vol. 175, 184 (1948)].

539.2

1607 THE DIFFUSION OF Xe-133 IN URANIUM OXIDES OF DIFFERENT OXYGEN CONTENTS.

R.Lidner and H.Matzke.
Z.Naturforsch., Vol.14a, No.5-6, 582-4 (May-June, 1959). In German.

The measurements were made in the temperature range 500-1150°C using the following materials. (1) UO_2 of approximately

stoichiometric composition and 0.63 μ average grain size (supplied by A.B.Atomenergi Stockholm). (2) As in (1) but oxidized to stoichiometric U_3O_8. (3) U_3O_8 of unknown origin, 0.65 μ average grain size. (4) $UO_{2.08}$ of 0.14 μ average grain size (supplied by A.E.R.E. Harwell) reduced or oxidized to the composition required. (5) $UO_{2.16}$ initial composition, 0.05 μ average grain size (also supplied by Harwell). The apparatus and method is described in detail. The activation energies of diffusion in $UO_{2.00}$; $UO_{2.03}$ and $UO_{2.12}$ are equal within the limits of error (48.9 ± 5.0; 51.0 ± 5.0 and 48.0 ± 6.1 kcal). For $UO_{2.00}$ in the temperature range 750-1150°C the diffusion coefficient $D = 2 \times 10^{-8} \exp(-48\,900/kT)$. The absolute value of the diffusion coefficient increases with increasing oxygen content in the UO_2 phase.
H.C.Cole

539.2

1608 THE THEORY OF THE DIRECTIONAL DISTRIBUTION OF RADIATION DAMAGE IN THE SILICON CRYSTAL LATTICE ON IRRADIATION WITH A MONO-ENERGETIC ELECTRON BEAM.

B.Ya.Yurkov.

Fiz. tverdogo Tela, Vol. 1, No. 5, 696-704 (May, 1959). In Russian.

Spencer's method (Abstr. 7117 of 1955) for calculating the directional distribution of energy dissipation is applied to find the distribution $\Sigma(x)$ of radiation damage in the silicon lattice. The moments of the distribution Σ_n are determined by generalizing Spencer's expression for the moments of the distribution of residual range I_{ln}^{P}. The moments are approximated by one function fulfilling the asymptotic trend of the distribution, $\Sigma(x)$, sought. The approximation was carried out separately for even and odd distributions. The theory is applied to Si and 0.5 MeV electrons, and compared with experimental results.
R.Berman

539.2

1609 RECIPROCITY RULE IN THE DISORDERING PROCESS IN CERTAIN CRYSTALLINE COMPOUNDS EXPOSED TO MEDIUM ENERGY ELECTRONS.

E.M.Belavtseva.

Dokl. Akad. Nauk SSSR, Vol. 125, No. 5, 1005-6 (April 11, 1959). In Russian.

Crystalline specimens often become amorphous when exposed to an electron beam in an electron microscope or in an electron diffraction camera. Samples of β-karotin and gramicidin C were exposed to electron beams of various energies and intensities, and exposure times required to produce disordered structures were measured. It is found that the reciprocity rule is not obeyed. The greatest deviation from the rule is observed at low radiation intensity
J.Adam

539.2 : 548.5 : 539.17

1610 PRODUCTION OF EXTREMELY HIGH CONCENTRATIONS OF LATTICE DEFECTS BY IRRADIATION OF SOLID BODIES IN REACTORS.

N.Riehl and R Sizmann.

Z. angew. Phys., Vol. 11, No. 6, 202-7 (June, 1959). In German.

A thin copper foil was coated on both sides with a layer of B^{10} (or Li^6) and irradiated in the Munich swimming-pool reactor. Lattice defects were produced in the copper by energetic α and Li^7 particles arising from the absorption of slow neutrons in the boron. The density of defects, as estimated from electrical resistivity measurements, was many orders of magnitude greater than that produced in uncoated copper foil.
B.T.M.Willis

ELECTRICAL PROPERTIES OF SOLIDS

(Superconductivity is included under Low-Temperature Physics)

539.2 : 537.3

1611 THE MEASURING OF THE ELECTRICAL RESISTANCE OF GOLD MONOCRYSTALS BY AN ALTERNATING CURRENT METHOD.

G.J.van den Berg and B.Franken.

Bull. Inst. Internat. Froid, Annexe 1958-1, 231-5.

The crystals have resistances ≅ 10^{-6} ohm at helium temperatures. Full details are given of the measuring technique.
D.J.Oliver

539.2 : 537.3

1612 ELECTRICAL CONDUCTIVITY OF THE ANTIFERROMAGNETIC COMPOUND CrSb.

I.G.Fakidov and A.Ya.Afans'ev.

Fiz. Metallov i Metallovedenie, Vol. 6, No. 1, 176-7 (1958). In Russian.

The temperature dependence of the resistivity ρ was studied from room temperature to 540°C. ρ was found to have a maximum near the Neél temperature.

539.2 : 537.3

1613 DEVIATIONS FROM MATTHIESSEN'S RULE IN ALUMINUM, TIN, AND COPPER ALLOYS.

P.Alley and B.Serin.

Phys. Rev., Vol. 116, No. 2, 334-8 (Oct. 15, 1959).

The electrical resistance of Al, Sn and Cu alloys was measured at 4.2°, 77°, and from 198° to 348°K. The Al alloys contained Zn, Mg, Ge, or Ag in various concentrations. The Sn alloys contained In, Sb, or Bi; and those of Cu contained Zn. At temperatures above 77°K, the impurity resistivity, $\delta\rho$, for a given solvent may be described by the equation $\delta\rho = \alpha(T)\rho_r$, where ρ_r is the residual resistivity, measured at 4.2°K, and T is the temperature. This result is independent of the nature of the solute. α is a constant in the temperature region 198° to 348°K. For Al and Sn $\alpha(273) \doteq 1.12$, whereas for Cu $\alpha(273) = 1.05$. The value of $\alpha(77)$ is about the same as at 273°K for Al and Cu, but for Sn $\alpha(77) = 1.08$. The temperature coefficient of the impurity resistivity for $198^\circ K < T < 348^\circ K$ was no larger than $1 \times 10^{-3}\,(^\circ K)^{-1}$. While several different theoretical models qualitatively describe these results, none can be quantitatively compared with experiment.

539.2 : 537.3

1614 NORDHEIM'S THEORY OF THE RESISTIVITY OF ALLOYS.

G.L.Hall.

Phys. Rev., Vol. 116, No. 3, 604-5 (Nov. 1, 1959).

Nordheim's theory (Abstr. 3907 of 1931) is extended to account for (1) ionic potentials that extend outside the unit cell, and (2) order of any range. It is shown that the original theory is less approximate than is generally asserted. As an incidental result, it is also shown that Flinn's electronic theory of order (Abstr. 1676 of 1957) can be extended appreciably.

539.2 : 537.3

1615 THE MEAN FREE PATH OF CONDUCTION ELECTRONS IN THE ALKALI METALS K, Rb and Cs.

R.Nossek.

Z. Naturforsch, Vol. 14a, No. 9, 840-1 (Sept., 1959). In German.

The resistance of thin films of the metals was measured as function of thickness at 90°K. Results for K and Br are in agreement with theoretical predictions on the assumption of free electrons, whereas in Cs

$$n/N\,(m/m_{eff})^{1/2} = 0.35,$$

where n = number of electrons, N = number of atoms per unit volume; m = mass of free electron, m_{eff} = effective mass.
L.Pincherle

539.2 : 537.3

1616 ELECTRICAL MEASUREMENTS ON PHOTOGRAPHIC EMULSION GRAINS. I. DARK CONDUCTIVITY.

J.F.Hamilton and L.E.Brady.

J. appl. Phys., Vol. 30, No. 12, 1893-1901 (Dec., 1959).

By exposing with light flashes delayed by short time intervals after the application of electric field pulses, it is possible to measure ionic conduction on large silver bromide grains from a photographic emulsion. Values of conductivity were obtained by an analysis of the transient decay of internal field pulses resulting from the application of known pulses of the external field. The internal field was measured by means of its effect in causing displacement of latent-image centres formed by the exposure flashes. The room-temperature ionic conductance of these grains was found to be the equivalent of about 9×10^{-6} ohm^{-1} cm^{-1} with an activation energy of about 0.42 eV. This conductance is several powers of ten higher than that reported for large silver bromide crystals of high purity and is thought to be primarily the result of surface effects. The implications of this result in terms of modern theories of photographic latent-image formation are discussed.

539.2 : 537.3

1617 ELECTRICAL MEASUREMENTS ON PHOTOGRAPHIC EMULSION GRAINS. II. PHOTOELECTRONIC CARRIERS.

J.F.Hamilton and L.E.Brady.

J. appl. Phys., Vol. 30, No. 12, 1902-13 (Dec., 1959).

Pulses of electric field applied to silver bromide grains of a photographic emulsion at short time intervals after the application of short light flashes cause displacement of photoelectrons and holes if their lifetimes are greater than the delay interval. The asymmetry in the location of the photoproducts—microscopically visible silver and bromine or developable latent-image specks—is an indication of the fraction of carriers free at the time the electric field is applied. As the delay interval is varied, the decay of the number of free carriers may be followed. In the emulsion studied, the number of photoelectrons was found to decay approximately according to a $1/(1 + \alpha t)$ law, falling to half the initial value in 0.25 μsec. The lack of a dependence on intensity or temperature is taken to indicate temporary trapping in a distribution of shallow traps, perhaps at the grain surface. The number of free holes decays by an exponential law, with a mean lifetime of about 15 μsec. Indications are that hole mobility is very low, owing either to temporary trapping or self-trapping. The implications of these results in terms of modern theories of latent-image formation are discussed.

539.2 : 537.3

1618 MAGNETORESISTANCE IN A MULTIVALLEY MODEL WITH ⟨110⟩-ELLIPSOIDS OF GENERAL SHAPE.

R.S.Allgaier.
Phys. Rev., Vol. 115, No. 5, 1185-8 (Sept., 1959).

Expressions are derived for the three weak-field magnetoresistance coefficients, b, c, and d, using a multivalley model having ellipsoids of general shape along the ⟨110⟩ directions in k space. The results are given in terms of statistical and scattering integrals and of the two mass ratios K and L needed to specify the relative values of the three effective-mass components characterizing the ellipsoids. The properties of b, c, and d as functions of K and L are discussed, including in particular the fact that the symmetry conditions which are appropriate for each of the three ellipsoid-of revolution models are satisfied along certain lines in the K-L plane.

539.2 : 537.3

1619 CHANGE OF SIGN OF THE HALL CONSTANT DURING THE ORDERING OF ATOMS IN AN ALLOY.

A.P.Komar, N.V.Volkenshtein and G.V.Fedorov.
Dokl. Akad. Nauk SSSR, Vol. 125, No. 3, 530-1 (1959). In Russian.

Investigation of the Hall e.m.f. E of the alloy Ni_3Mn (for heat treatment in a very wide temperature interval, down to the temperature of liquid He) showed that E depends to a large extent on the method of fixation of the alloy state investigated. When the alloy is cooled rapidly from 800°C to room temperature, it is found to be paramagnetic at the latter temperature, and the Hall constant is $R_0 = +0.09 \times 10^{-12}$ (V cm)/(A gauss). The E/B curves for this alloy with a degree of order < 1 show a marked decrease of E as B increases; at the liquid N and liquid He temperatures these curves intersect the abscissa, thus changing the sign of E. F.Lachman

539.2 : 537.3

1620 CONCERNING THE ANOMALOUSLY LARGE HALL EFFECT IN THE FERROMAGNETIC ALLOY CHROMIUM—TELLURIUM.

I.K.Kikoin, E.M.Buryak and Yu.A.Muromkin.
Dokl. Akad. Nauk SSSR, Vol. 125, No. 5, 1011-14 (April 11, 1959). In Russian.

During an investigation of galvomagnetic effects in ferromagnetic alloys containing a nonferromagnetic component, an anomalously large value for the ferromagnetic Hall coefficient (R_j) was discovered in a fifty atomic percent alloy of Cr-Te. The Curie temperature (θ) of the alloy was 54°C, and at a reduced temperature T where $T = 0.286\ \theta$, R_j for the alloy was 100 times greater than R_j for iron. Measurements of the Hall effect have been made below and above the Curie point of the alloy. Below, the variation of the Hall potential with magnetic field at a series of different temperatures leads to a curve for the temperature dependence of R_j from −200°C to 40°C, and also to the dependence of R_j on the square of the spontaneous magnetization. Above the Curie point the temperature dependence of the susceptibility and of the "paramagnetic" component of the Hall coefficient R_p are obtained. It is found that R_j for $T \geq \theta$ obtained from measurements below the Curie point is very close to the value obtained for R_p above the Curie point. One table and four graphs are included. W.Bardsley

539.2 : 537.3

1621 VARIATION OF THE ELECTRONIC STRUCTURE OF ALUMINIUM CAUSED BY α-IRRADIATION.

W.Kapp and F.Stangler.
Z. Phys., Vol. 154, No. 4, 486-94 (1959). In German.

90 hours irradiation by 52 mC of Po^{210} α-particles at liquid air temperature reduced the Hall coefficient of aluminium by 0.9% and the electric conductivity by 5.3%. One can conclude that the largest part of the effect is due to a decrease of electron mobility, but that there is also a small decrease in the number of holes. L.Pincherle

539.2 : 537.3

1622 ON THE EFFECT OF X-RADIATION ON THE IONIC CONDUCTIVITY OF NaCl. J.Hacke.

Z.Phys., Vol. 155, No. 5, 628-34 (1959). In German.

The ionic conductivity of single crystals exposed to X-rays was measured in the temperature range 200 to 650°C. Irradiation caused a fall in conductivity below 400°C but no change above. The phenomenon is explained by assuming the formation of vacancy complexes during the irradiation. B.T.M.Willis

539.2 : 537.3

1623 PLASMA OSCILLATION IN THE ELECTRICALLY CONDUCTIVE TIN OXIDE FILM.

K.Ishiguro, T.Sasaki, T.Arai and I.Imai.
J. Phys. Soc. Japan, Vol. 13, No. 7, 755-6 (July, 1958).

The optical constants n and k are calculated as a function of frequency ν using published figures for the relaxation frequency and the plasma frequency ν_p. The quantity $2nk/(n^2 + k^2)^2$ (representing the probability of energy loss of an electron beam penetrating the specimen) is then plotted against ν and found to pass through a sharp maximum at $\nu_{max} = 1.00 \times 10^{14}\ sec^{-1}$. ν_{max} is less than ν_p owing to the contribution of the valence and core electrons to the dielectric constant. B.T.M.Willis

Semiconductors

539.2 : 537.311

1624 VARIATIONAL APPROACH TO DEVIATIONS FROM OHM'S LAW. I.Adawi.

Phys. Rev., Vol. 115, No. 5, 1152-6 (Sept. 1, 1959).

In a perturbation framework, Kohler's variational method has been extended to obtain deviations from Ohm's law for a nondegenerate electron gas. Solution for the distribution function reduces to solving sets of linear algebraic equations. It is shown that, to second order in the field strength, the "popular" Maxwellian distribution (with a new temperature) is only a first-order variational solution. The method becomes extremely simple if the diffusion approximation is introduced and a relaxation time can be defined. Under these conditions, the second-order term in the mobility is expressed as the ratio of two infinite determinants using the usual representation, in which the unknown function is expressed as an energy polynomial. This ratio can be expressed by an infinite series.

539.2 : 537.311

1625 ON THE QUESTION OF THE FORMATION OF SEMICONDUCTING PHASES IN SYSTEMS CONTAINING TRANSITION METALS. L.D.Dudkin.

Dokl. Akad. Nauk SSSR, Vol. 127, No. 6, 1203-6 (Aug. 21, 1959). In Russian.

Since, in compounds which might be expected to be semiconductors (see Abstr. 8181 of 1956), the overlap between d-orbitals of transition metal atoms could give rise to metallic behaviour, the author defines a related factor $\Delta = 100\ (x-d)/x$ (x, the shortest distance between transition metal atoms in the compound, d the diameter of such atoms for the appropriate coordination) and finds that for $\Delta \geq 14.5\%$ semiconductivity is observed, while below this value these compounds are metallic. This appears to hold for numerous compounds in a variety of structures, and even, in the case of CrSb, for changes in Δ due to thermal expansion anisotropy.
C.H.L.Goodman

539.2 : 537.311

1626 THE EFFECT OF ILLUMINATION ON THE CONTACT POTENTIAL OF SOME SEMICONDUCTORS. I.A.Akimov.

Dokl. Akad. Nauk SSSR, Vol. 128, No. 4, 691-4 (Oct. 1, 1959). In Russian.

Variation of the contact potential under the influence of monochromatic light was studied (in air and in vacuum) by measuring the difference of the contact potential between a Pt electrode and a semiconductor, for both inorganic semiconductors (p-type TlI, n-type CdS, n-type ZnO) and for several organic dyes. Spectral characteristics of the contact photo-potential were established, and it was

shown that the method employed can be used for the determination of the sign of the carriers of the photo-current. The effect of the nature of insulating layers (mica, gelatine, quartz) on the magnitude and sign of the photo-potential was also investigated.
M.H.Sloboda

539.2 : 537.311

1627 APPLICATION OF THE PHOTOGALVANOMAGNETIC EFFECT IN MEASURING THE SURFACE RECOMBINATION RATE. T.I.Galkina.

Fiz. tverdogo Tela, Vol. 1, No. 2, 216-17 (Feb., 1959). In Russian

A method in which the photogalvanomagnetic effect voltage is compensated by the photoconductivity potential was used for determining the surface recombination rate in thin Ge specimens. The results were in good agreement with those obtained by the decaying photoconductivity method.
M.H.Sloboda

539.2 : 537.311

1628 A NEW LONGITUDINAL MAGNETO-CONCENTRATION EFFECT AND ITS USE IN DETERMINING THE RELATION BETWEEN THE CONCENTRATIONS OF HEAVY AND LIGHT HOLES. S.M.Ryvkin, Yu.L.Ivanov, A.A.Grinberg, S.R.Novikov and N.D.Potekhina.

Fiz. tverdogo Tela, Vol. 1, No. 9, 1372-5 (Sept., 1959). In Russian.

A uniform field is applied at right angles to the parallel planes bounding a semiconductor, and minority carriers are injected at a point at one side and collected by a point collector at opposite side. The field concentrates carriers near the axis and the concentration at the collector increases with field. It is shown how the relative concentrations of heavy and light holes can be calculated from such measurements. For n-type germanium of 3 ohm.cm and 10 ohm.cm the relative concentration was found to be 57.
R.Berman

539.2 : 537.311

1629 CRYSTAL POTENTIAL AND ENERGY BANDS OF SEMICONDUCTORS. I. SELF-CONSISTENT CALCULATIONS FOR DIAMOND. L.Kleinman and J.C.Phillips.

Phys. Rev., Vol. 116, No. 4, 880-4 (Nov. 15, 1959).

Approximate self-consistent potentials are constructed for diamond, first with exchange ignored, and then with exchange included according to the Slater free-electron approximation and according to a refined momentum-dependent free-electron approximation. The Hartree charge densities and energy gap are in fair agreement with experiment. Inclusion of valence exchange by the Slater approximation shows that Herman's earlier calculation (Abstr. 6122 of 1954) was nearly self-consistent in this approximation. Agreement with experiment on charge densities and energy gap is greatly improved in comparison with the Hartree results. Further inclusion of the momentum dependence of the exchange potential does not greatly improve the charge densities and the energy gap but does alter the valence band width.

539.2 : 537.311

1630 THEORY OF ELEMENTARY EXCITATIONS IN ATOMIC SEMICONDUCTORS. A.G.Samoilovich and S.L.Korolyuk.

Fiz. tverdogo Tela, Vol. 1, No. 10, 1592-9 (Oct., 1959). In Russian.

The variational method of Bonch–Bruevich (Abstr. 761 of 1955) is applied to the simple model of an atomic semiconductor in which each atom has a saturated valence shell, with two electrons. The Hamiltonian of the system of elementary excitations (electrons, holes, ortho- and para-excitons) is obtained to fourth order in the creation and annihilation operators of the excitations. It includes terms describing their free motion (activation energies and effective masses are compared), and also spontaneous transition processes and the electrostatic and dipole–dipole interactions between the excitations.
R.B.Stinchcombe

539.2 : 537.311

1631 TEMPERATURE DEPENDENCE AND LIFETIME IN SEMICONDUCTOR JUNCTIONS.
D.A.Jenny and J.J.Wysocki.

J. appl. Phys., Vol. 30, No. 11, 1692-8 (Nov., 1959).

The temperature dependence of a semiconductor p–n junction over a given temperature range can be held to a minimum by using material with a minority carrier lifetime below a certain maximum value. The first-order temperature dependence of the junction currents is then $i \alpha \exp(-E_g/2kT)$. rather than $i \alpha \exp(E_g/kT)$, over the entire operating temperature range. Calculations applied to gallium arsenide in monograph form show that an optimum lifetime should be practically attainable by controlled doping with recombination-centre impurities. The maximum-lifetime condition fixes the last remaining degree of freedom in the choice of semiconductor material properties for junction device design. The upper operating temperature limit of junction devices is calculated for germanium, silicon, indium phosphide, and gallium arsenide.

539.2 : 537.311

1632 MINORITY CARRIER CURRENT IN A LINEARLY GRADED DRIFT FIELD. D.P.Kennedy.

J. appl. Phys., Vol. 31, No. 1, 218-19 (Jan., 1960).

The effect of a linearly graded drift field on the magnitude of the hole current in an n-type semiconductor is investigated. Recombination effects are neglected.
P.T.Landsberg

539.2 : 537.311

1633 DIPOLE MODE OF MINORITY CARRIER DIFFUSION WITH REFERENCE TO POINT CONTACT RECTIFICATION. B.R.Gossick.

J. appl. Phys., Vol. 31, No. 1, 29-35 (Jan., 1960).

The dipole mode of minority carrier diffusion about a spherical emitter is presented. The current–voltage relationship, and frequency characteristics of this mode are determined. Compared with the unipole mode, which has been treated extensively, the dipole mode offers superior high-frequency performance, which is partially offset by an inferior d.c. characteristic curve. A representative numerical example gives 40 mμsec mean response time with the unipole mode and 0.5 mμsec with the dipole mode. It is proposed that the reproducibility of special diode characteristics might be improved by designing diodes to suppress either the unipole or dipole mode. Methods are suggested for the suppression of either mode.

539.2 : 537.311 : 541.18

1634 ELECTRONIC THEORY OF CHEMISORPTION ON THE REAL SURFACE OF A SEMICONDUCTOR.
Sh.M.Kogan and V.B.Sandomirskii.

Dokl. Akad. Nauk SSSR, Vol. 127, No. 2, 377-9 (July 11, 1959). In Russian.

According to the authors, the real surface is a surface with a large number of states not related to the adsorption of the given gas, while in an "idealized" surface all electronic surface states are due to the adsorption of that gas. It is shown that is is only the real surface model that can be used for explaining some observed facts (in particular the sharp lack of coincidence between the coverage with molecules and the charge of the surface).
F.Lachman

539.2 : 537.311 : 621.382.23

1635 SURFACE-DEPENDENT LOSSES IN VARIABLE REACTANCE DIODES. D.E.Sawyer.

J. appl. Phys., Vol. 30, No. 11, 1689-91 (Nov., 1959).

Surface effects may seriously degrade the h.f. performance of a semiconductor junction diode used as a variable reactance element without significantly degrading the diode's d.c. characteristics. Measurements on both p^+n and n^+p germanium alloy junction diodes have yielded a diode series equivalent resistance component in excess of the calculated integrated bulk resistance. This excess resistance decreased with frequency approximately as 1/f and for freshly etched devices could be varied by changing the atmosphere surrounding the diode. Those ambients which yielded a maximum surface-determined junction breakdown voltage also yielded a maximum frequency-dependent excess resistance. A model which can explain these observations assumes a surface inversion layer contiguous with the alloy junction.

539.2 : 537.311 : 621.382.2 .3

1636 INVESTIGATION OF THE TEMPERATURE VARIATION OF NOISE IN DIODE AND TRANSISTOR STRUCTURES.
C.A.Lee and G.Kaminsky.

J.appl. Phys., Vol.30, No.12, 1849-55 (Dec., 1959).

Measurements of the white noise of transistors (principally, diffused-base structures) and diodes have been made at temperatures ranging from about 77° to 300°K for a range of about two decades in injection level, and from 10 kc/s to 10 Mc/s. Comparisons of the noise measurements with calculated levels are presented. The germanium transistors, show a progressively increasing deviation from the theory as the temperature is decreased, and most of the silicon transistors exhibited excess white noise at room temperature and below.

539.2 : 537.311

1637 LONG-LASTING CHANGES OF THE CONTACT POTENTIAL AND CONDUCTIVITY OF GERMANIUM CAUSED BY THE ACTION OF LIGHT AND A TRANSVERSE ELECTRIC FIELD.

M.S.Kosman and I.I.Abkevich.

Fiz. tverdogo Tela, Vol. 1, No. 3, 378-87 (March, 1959). In Russian.

An increase in the negative charge of the "slow" surface traps was observed in Ge exposed to light, and it was shown that in the short wavelength range the variation of the contact potential and resistivity of Ge due to the heat effect is small in comparison with that caused by the increase in the negative surface charge. Various surface models were analysed and it was shown that only that proposed by Kingston and McWhorter (Abstr. 7410 of 1956) leads to the time dependence of the contact potential that is in good agreement with the experimental results. M.H.Sloboda

539.2 : 537.311

1638 ON THE CORRELATION BETWEEN THE CAPTURE CROSS-SECTION RATIO AND THE ENERGY LEVELS OF THE SURFACE RECOMBINATION CENTRES IN GERMANIUM.

A.V.Rzhanov.

Fiz. tverdogo Tela, Vol. 1, No. 3, 522-4 (March, 1959). In Russian.

The results of measurements carried out in vacuo at 300°K on n-type Ge specimens (18-30 ohm cm), etched in boiling H_2O_2 (with an addition of an alkali) and either untreated or vacuum-annealed at various temperatures, between 350° and 450°K, were plotted in the form of a d_p/d_n versus ϵ_t graph, where d_p and d_n are the capture cross-sections for holes and electrons, respectively, and ϵ_t is the energy level of the surface recombination centres, measured in relation to the Fermi level in Ge with intrinsic conductivity. The physical nature of this relationship - compared with that obtained by Many and Gerlich (Abstr. 613 of 1958) - was explained by postulating different charge-states of the surface recombination centres and attributing ionic-covalent character to the bond between atoms constituting the surface recombination centres, and by assuming that the obtained surface recombination rate versus surface potential curves represented, in fact, a sum total of effects of two different recombination centres. M.H.Sloboda

539.2 : 537.311

1639 AN INVESTIGATION OF FAST SURFACE STATES IN GERMANIUM.

V.G.Litovchenko and V.I.Lyashenko.

Fiz. tverdogo Tela, Vol. 1, No. 10, 1609-21 (Oct., 1959). In Russian.

The pulsed-field effect method was used for studying the topography of fast surface states in p-type specimens cut perpendicular to (110) axis, and having ρ = 20-30 ohm cm, a volume lifetime of 200-1000 μsec, a surface recombination rate of 50-300 cm/sec. The apparatus could be evacuated to 10^{-6} mm Hg or filled with various gases. Graphs show the dependence of conductivity change on the charge induced on the surface for various conditions, and the dependence of trapped charge density in fast states on the surface potential. It is suggested that localized levels in forbidden zone are specific for each type of external atom, but the small differences in effective depths reported by various authors are due to the small number of possible atoms (or molecules) arising from the methods of production of germanium. R.Berman

539.2 : 537.311

1640 INTERACTION BETWEEN ARSENIC AND ALUMINUM IN GERMANIUM.

J.O.McCaldin.

J. appl. Phys., Vol. 31, No. 1, 89-94 (Jan., 1960).

The behaviour of As in Ge containing regions doped with $\sim 5 \times 10^{20}$ per cm^3 of Al was studied. The solubility of As is enhanced tenfold or more by the heavy Al doping, on the basis of (1) measurements of conductivity type and (2) the negative results of a search for compounds by X-ray diffraction. The behaviour of As diffusion fronts was studied by observing the progress of the p—n junction formed in Ge containing 10^{17} per cm^3 of In. When a region of heavy Al doping was added, the p—n junction was displaced. The displacements indicate that the diffusing As is attracted to regions of heavy Al doping. These results are similar to those of Reiss, Fuller, and others for Li in Si, though a detailed understanding is not yet available in the present case.

539.2 : 537.311

1641 ENDOTHERMICITY AND POSITIVE EXCESS ENTROPY IN SOLID SOLUTIONS IN GERMANIUM AND SILICON.

R.A.Oriani and R.N.Hall.

J. Phys. Chem. Solids, Vol. 6, No. 1, 97-8 (July, 1958).

This letter deals with the observed fact that a number of solutes in silicon and germanium have distribution coefficients which are linear in the reciprocal temperature. The circumstance that the intercepts on the 1/T = 0 axis are rather larger than expected is discussed. P.T.Landsberg

539.2 : 537.311

1642 RADIATIVE SURFACE EFFECT IN GERMANIUM.

J.I.Pankove.

J. Phys. Chem. Solids, Vol. 6, No. 1, 100-1 (July, 1958).

Observed radiations of 1.9μ and 4.6μ are ascribed to bulk recombination and an interband transition of light holes respectively. A maximum value of 0.31 eV is deduced for the surface potential. D.J.Huntley

539.2 : 537.311

1643 STRAIN-INDUCED CHANGES IN THE SEEBECK COEFFICIENT OF N-TYPE GERMANIUM.

J.R.Drabble and R.D.Groves.

Phys. Rev. Letters, Vol. 2, No. 11, 451-2 (June 1, 1959).

From measurements on oriented specimens of n-germanium (carrier concentration 3×10^{14} cm^{-3}) at temperatures of 82° and 95.5°K, the large changes parallel to the applied stress observed on the [111]- and [110]-oriented specimens and the small change observed on the [100]-oriented specimens, were interpreted as indicating that the changes occurred as a result of strain-induced changes in carrier populations of the different valleys. The ratio (parallel to perpendicular) of components of the phonon-drag Seebeck tensor for a single valley is 9.6 ± 0.3 at 82°K and 9.5 ± 0.5 at 95.5°K in agreement with previous estimates by Herring and colleagues. C.A.Hogarth

539.2 : 537.311 : 539.1.07

1644 PERFORMANCE OF GERMANIUM AND SILICON SURFACE BARRIER DIODES AS ALPHA-PARTICLE SPECTROMETERS.

J.W.Mayer.

J. appl Phys., Vol.30, No.12, 1937-44 (Dec., 1959).

The characteristics of a germanium surface barrier diode operated at room temperature make it particularly useful as an alpha-particle spectrometer. The small size, stability, energy resolution, and relative insensitivity to β and γ-radiation of the units suggest applications in medical and nuclear research. Studies were made on Au-Ge and Au—Si surface barriers with a barrier width (≅1μ) less than the range of the incident alpha particles. In the germanium units, the pulse-height response to alpha particles increased linearly with energy up to 7.5 MeV and then increased monotonically but more slowly as the energy rose to 12 MeV. In silicon the deviation from linearity occurred around 6 MeV. The observed linearity between pulse height and energy depends simply on the fact that the number of carriers excited is proportional to the particle energy and that the time for the carriers to be collected at the barrier is less that the circuit time constant. The general theory of the transient response of the diode was developed and the calculated response compared with the observed behaviour. The observed values of the energy required to create a hole—electron pair, measured over the energy range of linear response of the junction, were $\epsilon_{(Ge)}$ = 2.96 ± 0.1 eV and $\epsilon_{(Si)}$ = 3.9 ± 0.3 eV.

539.2 : 537.311

1645 MEASUREMENT OF THE LIFETIME OF CARRIERS PRODUCED IN SILICON BY ELECTRON BOMBARDMENT.

A.Vapaille.

C.R. Acad. Sci. (Paris), Vol. 249, No. 5, 648-50 (Aug. 3, 1959). In French.

For a p-type crystal electrons with energies less than 15 keV produce an increase in resistivity which is thought to be due to electric fields resulting from changes in the populations of surface states. Electrons of higher energy reduce the resistance. The lifetime τ of the excess carriers was measured as a function of temperature. For an n-type sample τ increases monotonically with temperature giving an activation energy of 0.028 eV. For a p-type sample τ passes through a maximum and no explanation can be offered for this behaviour. D.J.Oliver

539.2 : 537.311

1646 THE POSSIBILITY OF PRODUCING OHMIC CONTACTS ON SILICON BY THE DRY FRICTION METHOD.

I.D.Kirvalidze and V.F.Zhukov.

Fiz. tverdogo Tela, Vol.1, No.10, 1583-6 (Oct., 1959). In Russian.

Ohmic contacts on n– and p-type Si specimens were prepared by bringing a flat surface of a Si single crystal against the flat face of a rotating specimen of one of the following materials: Mo, Fe, brass, Sn, Ta, bronze, Ni, Cu and Al. The current–voltage characteristics were determined for (a) polished Si surface, (b) etched or polished Si coated with electro-deposited Ni, and (c) Si surface coated with the investigated materials applied by the dry friction method. The presence of the "disturbed" surface layer (ensuring the formation of good ohmic contact) was observed in specimens on which Ni and Al were deposited by the studied method.

M.H.Sloboda

539.2 : 537.311

1647 THE RELATIONSHIP BETWEEN THE MAGNETIC FIELD INTENSITY AND HALL EFFECT IN SILICON.

N.S.Orlova and V.M.Tuchkevich.

Fiz. tverdogo Tela, Vol.1, No.10, 1631-4 (Oct., 1959). In Russian.

The Hall coefficient R, measured on n– and p-type Si single crystals at 114°, 136° and 300° K, increased almost linearly with increasing intensity of the magnetic field H reaching a practically constant value at approximately $H \cong 9 \times 10^3$ Oe. The $R/R_{max.} = f(H)$ relationship at various temperatures was also determined; the results obtained for n– and p-type Si specimens were in good qualitative agreement.

M.H.Sloboda

539.2 : 537.311

1648 LIGHT EMISSION AND NOISE STUDIES OF INDIVIDUAL MICROPLASMAS IN SILICON P–N JUNCTIONS.

A.G.Chynoweth and K.G.McKay.

J. appl. Phys., Vol. 30, No. 11, 1811-13 (Nov., 1959).

At low currents in the prebreakdown region of broad area diffused silicon p–n junctions in which the breakdown is by an avalanche mechanism, only a few light-emitting microplasmas are present. These appear in succession as the current is increased and the appearance of each spot is accompanied by its own set of characteristic microplasma current pulses. It is found also that effectively all the emitted light arises at these microplasmas and that they carry, essentially, all of the breakdown current. The light intensity of an individual microplasma is roughly proportional to the current flowing through it.

539.2 : 537.311 : 621.382.233 : 621.374.32

1649 TWO-TERMINAL ASYMMETRICAL AND SYMMETRICAL SILICON NEGATIVE RESISTANCE SWITCHES.

R.W.Aldrich and N.Holonyak, Jr.

J.appl. Phys., Vol.30, No.11, 1819-24 (Nov., 1959).

By making use of an emitter region shorted by a metallic contact to an adjacent base region, a new form of p–n–p–n switch is obtained. Several new structures are described, including a symmetrical (or a.c.) switch. Typical experimental results on switches which breakdown in the range from 25 to 40 V are presented.

539.2 : 537.311

1650 EFFECT OF INTERNAL HEATING ON THE BREAKDOWN CHARACTERISTICS OF SILICON P–N JUNCTIONS.

B.Senitzky and P.D.Radin.

J. appl. Phys., Vol. 30, No. 12, 1945-50 (Dec., 1959).

The breakdown characteristics of two types of silicon p–n junctions are studied. In the first type of junction which is commonly encountered, the breakdown occurs in many localized regions, the characteristic being determined by the aggregate effect of the localized regions; in the second type of junction the geometry is such that only one localized breakdown region occurs. Whereas the simple avalanche theory can explain the onset of breakdown for both types of junctions, the shape of the V–I curve in the breakdown region cannot be explained without the inclusion of another variable in the theory. Experimental evidence obtained by the use of pulse techniques indicates that this variable is the temperature rise due to the current flowing through the junction. It is found that this self-heating is the most important single factor in determining the shape of the V–I curve and that almost the entire dynamic resistance in this region is due to this effect. A method is given for determining the temperature rise of the junctions, provided that the V–I characteristic is known.

539.2 : 537.311

1651 HEAT TREATMENT CENTERS AND BULK CURRENTS IN SILICON P–N JUNCTIONS.

D.J.Sandiford.

J. appl. Phys., Vol. 30, No. 12, 1981-6 (Dec., 1959).

A set of small-area, alloy, p–n junction diodes was made from a slice of heat-treated n-type silicon. The carrier lifetimes of the diodes were found to be in the range from 2.5×10^{-8} to 3.5×10^{-6}sec. Measurements were made of the lifetime and of the current–voltage characteristics in the forward and reverse directions as a function of temperature from room temperature to 165°C. An analysis of the results and, in particular, the correlation of current flow with lifetime values, showed that for the diodes with the shortest lifetimes, centres situated 0.48 eV at 0°K from either the conduction or valence bands were responsible for large space-charge currents. For the diodes with lifetimes in the microsecond range, surface leakage current were predominant. Evidence was found of a field-dependent emission probability β for these centres. The results showed than $\beta \sim E^{0.35}$ when E, the electric field, is in the range of 2×10^4 to 8×10^4 V/cm.

539.2 : 537.311

1652 IMPURITY EFFECTS UPON MOBILITY IN SILICON.

R.A.Logan and A.J.Peters.

J. appl. Phys., Vol. 31, No. 1, 122-4 (Jan., 1960).

In sufficiently pure n-type silicon, the carrier mobility follows a $T^{-1.5}$ law at low temperature and agrees well with Herring's theory of lattice scattering mobility. Similar results for p-type silicon give a T^{-2} law for the temperature dependence and is in disagreement with theory. In less pure samples, scattering is by ionized impurities and the magnitude of the mobility reduction agrees well with the theory of Herring and Brooks. Scattering by large concentrations (~ 10^{18} cm^{-3}) of dissolved neutral oxygen is negligible compared to that by other mechanisms.

539.2 : 537.311

1653 IONIZED-IMPURITY SCATTERING MOBILITY OF ELECTRONS IN SILICON.

D.Long and J.Myers.

Phys. Rev., Vol. 115, No. 5, 1107-18 (Sept. 1, 1959).

Curves were obtained of the temperature dependence of the electron mobility in a set of n-type silicon samples of varying impurity content and compensation between about 30° and 100° K by combining data from electrical resistivity and Hall effect measurements. The curves were used in an experimental test of the applicability of the Brooks–Herring formula to the ionized-impurity scattering of electrons in silicon under conditions for which the Born approximation is valid. Impurity concentrations in the samples were determined by analysis of the Hall versus temperature data. It was necessary to correct for the lattice-scattering contribution to the observed mobility in comparing the Brooks–Herring formula with the experimental results. It is found that the formula gives a good quantitative description of the results when an electron effective mass of 0.3 of the true mass is used, provided that the ion scattering is not too strong. When ion scattering is dominant, however, such as at low temperatures in relatively impure samples, there is a discrepancy between formula and results which may be due to electron–electron interactions. (See also following abstract).

539.2 : 537.311

1654 HALL EFFECT AND IMPURITY LEVELS IN PHOSPHORUS-DOPED SILICON.

D.Long and J.Myers.

Phys. Rev., Vol. 115, No. 5, 1119-21 (Sept. 1, 1959).

An experimental study was made of the energy level structure of a phosphorus donor impurity in silicon, using Hall coefficient and Hall mobility measurements on six samples of widely varying impurity content and compensation. The main purpose was to test the Kohn–Luttinger theoretical model which predicts a splitting of the sixfold degenerate (excluding spin) ground "1s" level, with a single state being depressed in energy by between 0.009 and 0.015 eV relative to the remaining fivefold degenerate level. The splitting energy can be measured by comparing carrier concentration versus temperature curves corresponding to this energy level scheme with experimental curves derived from Hall data. The curves for these samples all agree well with the Kohn–Luttinger model for splitting energies of between 0.009 and 0.012 eV, in agreement with the theoretical prediction.

539.2 : 537.311

1655 HIGH-FIELD EFFECT IN BORON-DOPED SILICON.

R.D.Larrabee.

Phys. Rev., Vol. 116, No. 2, 300-1 (Oct. 15, 1959).

Two samples of boron-doped silicon were observed to have a linear current-voltage characteristic at liquid nitrogen temperature (77°K) up to fields of 10^4 V/cm. This result was not expected since saturation of drift velocity is expected to occur at these high fields. Indeed, the current-voltage characteristic at 183°K did show the saturation effects expected. The experimental data seem to indicate that there is an appreciable amount (94%) of de-ionization of the boron level at 77°K and that the capture cross-section of the ionized boron levels decreases as the hole drift velocity increases in the applied field. Since the thermal ionization rate is substantially independent of field, this implies that the steady-state number of carriers will be increased at the higher fields.

539.2 : 537.311 : 537.533

FIELD EMISSION FROM SILICON AND TELLURIUM SINGLE CRYSTALS. See Abstr. 1145

539.2 : 537.311

1656 ENERGY LEVELS IN NEUTRON-IRRADIATED n-TYPE SILICON. G.Rupprecht and C.A.Klein.

Phys. Rev., Vol. 116, No. 2, 342-3 (Oct. 15, 1959).

Pulsed-field effect experiments were performed with the aim of detecting deep-lying radiation-induced energy levels and estimating their electron capture cross-sections. Evidence was found in favour of two, deep-lying states in the upper part of the energy gap, at 0.15 and 0.37 eV below the conduction band edge. The electron capture cross-sections associated with these two levels strongly suggest that both are acceptor-like.

539.2 : 537.311

1657 SEMICONDUCTING PROPERTIES OF ALUMINIUM SELENIDE. V.P.Mushinsky.

Fiz., tverdogo Tela, Vol. 1, No. 3, 515-17 (March, 1959). In Russian.

Resistivity ρ of vacuum-melted Al—Se alloys was measured and the temperature dependence of electrical conductivity σ was determined. Maximum ρ (approximately $10^{8.5}$ ohm cm immediately after melting, and $10^{6.5}$ ohm cm after annealing at 250°C) was observed in the alloy of the composition corresponding to the intermetallic compound Al_2Se_3. σ varied with temperature according to

$$\sigma = A_1 e \exp(-\Delta E_1/2kT) + A_2 e \exp(-\Delta E/2kT),$$

where $\Delta E_1 = 0.04\text{-}0.12$ eV, and $\Delta E = 1.5\text{-}1.6$ eV. Alloys containing not < 60 wt % Se were characterized by p-type conductivity (both in air and in vacuum); alloys with a lower Se content had n-type conductivity below -40°C and p-type above this temperature.

M.H.Sloboda

539.2 : 537.311

1658 ANOMALOUS SKIN EFFECT IN BISMUTH. G.E.Smith.

Phys. Rev., Vol. 115, No. 6, 1561-8 (Sept. 15, 1959).

High-frequency (23.5 kMc/s) surface resistance measurements were made on plane surfaces of single-crystal bismuth at 2°K as a function of orientation. Extreme anomalous skin effect conditions were found to prevail, allowing details of the Fermi surface to be deduced from Pippard's theory. In Shoenberg's model of the electron band, components of the inverse effective-mass tensor divided by the Fermi energy are found to be $\alpha_1/E_e = 9.10$, $\alpha_2/E_e = 0.088$, $\alpha_3/E_e = 4.7$, and $\alpha_4/E_e = 0.38$ (in units of 10^3/eV). These results are in essential agreement with values obtained from de Haas—van Alphen experiments and cyclotron resonance. The number of ellipses is definitely established to be six and the number of electrons found to be $N = 5.5 \times 10^{17}/cm^3$. The parameters for the two hole ellipsoids are found to be $\beta_1/E_h = \beta_2/E_h = 1.5$ and $\beta_3/E_h = 0.12$. Assuming Shoenberg's value $E_e = 0.0177$ eV, the value $E_h = 0.00112$ eV is calculated from specific heat data. It is also found that the reflection of carriers from the surface of the sample is predominantly specular in contrast to diffuse reflection found in other metals.

539.2 : 537.311

1659 THE ELECTRICAL PROPERTIES OF ALLOYS OF BISMUTH. IV. ON THE CALCULATION OF THE ELECTRICAL PROPERTIES OF BINARY ALLOYS OF BISMUTH. G.A.Ivanov.

Fiz. tverdogo Tela, Vol. 1, No. 10, 1600-8 (Oct., 1959). In Russian.

It is shown that the isotropic two zone model with density of states $g(E) \sim E^{\frac{1}{2}}$ can be applied to the evaluation of the concentrations and mobilities of the current carriers in polycrystalline specimens of bismuth—tellurium and bismuth—selenium alloys. The same model is applied to the calculation of the concentrations of the current carriers in bismuth—tin and bismuth—lead alloys. The character of the change of the mobility of the carriers in the binary alloys is also discussed. R.B.Stinchcombe

539.2 : 537.311

1660 ELECTRICAL PROPERTIES OF CADMIUM ANTIMONIDE ALLOYED WITH INDIUM.

I.M.Pilat, V.D.Iskra and V.B.Shuman.

Fiz. tverdogo Tela, Vol. 1, No. 3, 393-6 (March, 1959). In Russian.

The temperature dependence of the electrical conductivity σ, the thermo-e.m.f. α, and the Hall constant R, as well as the activation energy ΔE, were determined for pure CdSb and for specimens of this compound containing up to 0.1% In. At low temperatures, σ of the In-bearing specimens was 30-200 times lower than that of the pure material, this difference becoming insignificant at higher temperatures. In all the In-bearing specimens, R changed its sign from positive (below room temp.) to negative (at higher temp.). α of all the In-bearing specimens was negative above room temperature, and ΔE was also affected by the presence of In. M.H.Sloboda

539.2 : 537.311

1661 THE EFFECT OF ELECTRIC FIELD ON THE ELECTRIC CONDUCTIVITY OF POLYCRYSTALLINE CADMIUM SELENIDE. I.M.Yashukova.

Fiz. tverdogo tela, Vol. 1, No. 3, 388-92 (March, 1959). In Russian.

Experimental results obtained by the pulse method showed that within the investigated temperature ranges (-47° to 178°C) and electrical field strength U — up to 2×10^4 V/cm, the variation of electrical conductivity σ with increasing U followed Poole's law. The activation energy determined for CdSe from the temperature dependence of σ was 0.6-0.75 eV; it was postulated that these values are associated with the impurity levels. M.H.Sloboda

539.2 : 537.311

1662 EFFECTS OF DEUTERON BOMBARDMENT ON CdS SINGLE CRYSTALS. S.Tanaka and T.Tanaka.

J. Phys. Soc. Japan, Vol. 14, No. 1, 113-14 (Jan., 1959).

Flake shaped pure CdS single crystals with a high dark resistivity were bombarded in air at room temperature by 2 MeV deuterons to a total flux of 10^{16} cm^{-2}. The resistivity of the crystals falls from 10^{10} to 10^4 ohm cm and the donor levels produced lie about 0.4 eV below the conduction band. These levels are attributed to sulphur vacancies or interstitial cadmium ions. Also an increase in photosensitivity and shift in the absorption edge towards longer wavelengths is attributed to other defect levels at 2.0 eV below the conduction band. In addition the time dependence of the photocurrent suggests the formation of hole traps. W.Bardsley

539.2 : 537.311

1663 DEPENDENCE OF THE HOLE IONIZATION ENERGY OF IMPERFECTIONS IN CADMIUM SULFIDE ON THE IMPURITY CONCENTRATION. R.H.Bube and A.B.Dreeben.

Phys. Rev., Vol. 115, No. 6, 1578-82 (Sept. 15, 1959).

For previous work see J. Phys. Chem. Solids, Vol. 1, 234 (1957). The variation of the hole ionization energy of imperfections in cadmium sulphide as a function of the impurity concentration was measured using photoconductivity in a series of CdS:Ga:Cu powders. The Cu concentration varies from 4×10^{17} to 2×10^{20} cm^{-3}, and each sample was prepared with a Cu-concentration to Ga-concentration ratio of 1.05. The hole ionization energy of the sensitizing centres, as determined from the thermal quenching of photoconductivity, decreases from about 1.0 eV for low Cu concentrations to about 0.3 eV for 2×10^{20} Cu cm^{-3}. The results are analogous to other recent findings of small hole ionization energies in CdS and CdSe crystals.

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1664 APPLICATION OF ELECTRO-OPTICAL EFFECTS TO THE ANALYSIS OF THE ELECTRICAL CONDUCTION PROCESS IN CdS SINGLE CRYSTALS.

K.W.Böer, H.J.Hänsch and U.Kümmel.

Z. Phys., Vol. 155, No. 2, 170-83 (1959). In German.

Darkening caused by the displacement of the absorption edge to lower wavelengths was used to study, both at the room temperature and at -180°C, the non-homogeneous distribution of applied field, space charge and conduction in single crystals of CdS with evaporated contacts of Au and In. An annular region of maximum field was observed around the cathode. Possible mechanisms are discussed and similarity with observations in gas discharge physics noted.

G.C.Williams

539.2 : 537.311

1665 NON-HOMOGENEOUS FIELD DISTRIBUTION IN CdS SINGLE CRYSTALS IN THE RANGE OF HIGHER FIELD INTENSITIES. K.W.Böer.

Z. Phys., Vol. 155, No. 2, 184-94 (1959). In German.

Discusses a model permitting interpretation of the experimental results of Böer, Hänsch and Kümmel (see preceding abstract) based on field excitation of electrons from energy levels in the forbidden zone to the conduction band. G.C.Williams

539.2 : 537.311

1666 INFLUENCE OF FIELD EMISSION ON THE DISTRIBUTION OF STRONG FIELDS IN SOLIDS.

E.I.Adirowitsch.

Z. Phys., Vol. 155, No. 2, 195-205 (1959). In German.

Following on the observation of field inhomogeneity in CdS by Böer et al. (see preceding abstracts), the author discusses the mechanism by which a region of high field may be set up near the cathode and the way in which it may move as the applied voltage is varied. The equations for the stationary state are solved with simplifying assumptions, taking into account not only inter-band emission, but also field emission from the cathode. K.W.Plessner

539.2 : 537.311

1667 FORMATION OF CESIUM ANTIMONIDE. I. ELECTRICAL RESISTIVITY OF THE FILM OF CESIUM–ANTIMONY SYSTEM.

K.Miyake.

J. appl. Phys., Vol. 31, No. 1, 76-81 (Jan., 1960).

The films of Cs–Sb alloys whose compositions were determined by the weighing method, were prepared at the temperature range from 70° to 100° C. The electrical resistance and its temperature dependency of the samples, of which atomic ratio of Cs to Sb was ranged from 0.91 to 4.86, were measured. The reproducibility of electrical resistance was obtained for all the samples, except for $Cs_{3.30}Sb$, and the temperature coefficients of resistance of the samples, except for $Cs_{0.91}Sb$, were all negative. It was found that three compounds, CsSb, Cs_3Sb_2, and Cs_2Sb in addition to Cs_3Sb, having a remarkably high resistance, could be formed. The observed values of the electrical resistivity at 0° C and the thermal activation energy associated with conductivity were 1.84×10^3 ohm cm, 0.61 eV for $Cs_{1.02}Sb$; 1.82×10^3 ohm cm, 0.76 eV for $Cs_{3.02}Sb_2$; 2.85×10^3 ohm cm, 0.62 eV for $Cs_{2.02}Sb$; and 1.95×10^3 ohm cm, 0.77 eV for $Cs_{3.33}Sb$. The alloys with atomic ratio above 4 looked gold in reflected light, and those with atomic ratio above 5 were not formed.

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1668 THE DEPENDENCE OF THE ELECTRICAL CONDUCTIVITY OF COPPER OXIDE ON OXYGEN PRESSURE AT HIGH TEMPERATURES. III.

K.P.Zuev.

Fiz. tverdogo Tela, Vol. 1, No. 5, 774-82 (May, 1959). In Russian.

For Pt II see Abstr. 13294-5 of 1959. Uses a modification of the experimental method already described for temperatures in the range 1000 - 1250°C, for normal atmospheric pressure and for partial oxygen pressures in the range 1 to 760 mm Hg. Reproduced curves of $\log \sigma = f(T^{-1})$ indicate 1) a shift to higher Cu_2O conductivity σ with increasing oxygen pressure, 2) a shift of the point where the slope of the curve suddenly increases towards lower temperatures with increasing oxygen pressure. The energy of activation in good conducting Cu_2O samples at average temperatures is shown to have reduced values compared with the degassed state in the stabilisation region. Further curves show $\log \sigma = f[\log p(O_2)]$ for fixed T between 700° and 1115°C. An explanation is offered of the various data and the approximate character of the Wagner–Schottky model is discussed. D.E.Brown

539.2 : 537.311

1669 PREPARATION OF HIGH PURITY INDIUM ANTIMONIDE SINGLE CRYSTALS BY ZONE MELTING.

K.I.Vinogradova, V.V.Galavanov, D.N.Nasledov and L.I.Solov'yeva.

Fiz. tverdogo Tela, Vol. 1, No. 3, 403-6 (March, 1959). In Russian.

The variation of electrical conductivity, Hall constant and current carrier mobility across the length of ultra-high purity, zone-refined InSb single crystals was determined at room temperature and at −196°C. The results proved the effectiveness of the refining method, described in detail previously (Abstr. 1989 of 1959). M.H.Sloboda

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1670 ELECTRON IRRADIATION OF INDIUM ANTIMONIDE.

L.W.Aukerman.

Phys. Rev., Vol. 115, No. 5, 1125-32 (Sept. 1, 1959).

The effects of 4.5 MeV electron bombardment on the electrical properties of n- and p-type InSb were studied. Isochronal annealing experiments carried out on samples bombarded at 80° K indicate three regions of rapid annealing, the first two between 80° and 200° K and the third near room temperature. It is shown that the distribution of bombardment-produced energy levels is altered by heating a bombarded specimen to 200° K. The changes which occur as a result of this heat treatment suggest that energy levels are shifted as defects rearrange themselves into positions of greater stability. For samples bombarded at 200° K, the positions of energy levels and the rates at which they are generated are determined from careful studies of the temperature dependence of carrier concentration. Mobility changes are utilized to identify donor or acceptor behaviour. The levels introduced into the forbidden band appear to be multiply ionized.

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1671 ELECTRON IRRADIATION OF INDIUM ARSENIDE.

L.W.Aukerman.

Phys. Rev., Vol. 115, No. 5, 1133-5 (Sept. 1, 1959).

The carrier concentration of n-type InAs increases during irradiation with 4.5 MeV electrons. The increase was followed to a carrier concentration of $10^{17}/cm^3$. The carrier concentration of p-type samples decreases with irradiation. The increase in the electron concentration suggests that bombardment-produced donors are at least doubly ionized, even when the Fermi level is in the conduction band. Initially p-type samples exhibited anomalies which may result from n-type conduction in the vicinity of dislocations.

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1672 PLASMA PINCH EFFECTS IN INDIUM ANTIMONIDE.

M.Glicksman and M.C.Steele.

Phys. Rev. Letters, Vol. 2, No. 11, 461-3 (June 1, 1959).

Previous results on n-type InSb at 77° K (Abstr. 6974 of 1959) are now interpreted as indicating pinch effects for the current of hole-electron pairs, analogous to the well-known effects in gaseous plasmas. Further work is described and the time of quasi-stability of the pinch is found to be of order 1 µsec. C.A.Hogarth

539.2 : 537.311

1673 LOW-FIELD ELECTRICAL BREAKDOWN IN N-INDIUM PHOSPHIDE.

M.C.Steele.

J. Phys. Chem. Solids, Vol. 9, No. 1, 93-4 (Jan., 1959).

Current–voltage characteristics of n-type InP single crystals at 4.2° K show three distinct regions: (a) pre-breakdown where $1 \propto V^{1\cdot22}$; (b) breakdown where the current increases by two orders of magnitude without any further increase in voltage; (c) post breakdown where $I \propto V^2$. Probable mechanisms to account for the results are proposed, but further work with purer crystals is necessary to give a precise interpretation. G.C.Williams

539.2 : 537.311

1674 THE GALVANOMAGNETIC PROPERTIES OF THE PHOSPHIDES OF MANGANESE.

I.G.Fakidov and V.P.Krasovskii.

Fiz. Metallov i Metallovedenie, Vol. 7, No. 2, 302-4 (1959). In Russian.

The Hall e.m.f. and longitudinal and transverse magnetoresistive effects were measured for a series of Mn phosphides containing various proportions of MnP (ferromagnetic) and Mn_2P. In all cases, the conductivity was p-type. The number of current carriers in MnP was determined from the Hall parameter at the Curie point ($\Theta_C = 22°C$) and was 2×10^{22} cm^{-3}, assuming p-type only. The magnetoresistive change ($\Delta R/R$) was represented by $aH^{2/3}$ at Θ_C, by cH at temperature $< \Theta_C$ and by bH^2 at temperature $> \Theta_C$ where a, b, c depend on composition and temperature $\Delta R_\perp/R$ for MnP showed a maximum at 22° C in all fields. [English summary: PB 141126T-9, obtainable from Office of Technical Services, U.S. Dept. of Commerce, Washington, D.C., U.S.A.]. A.F.Brown

539.2 : 537.311

1675 ELECTRICAL PROPERTIES OF POLYCRYSTALLINE SELENIUM CONTAINING [UP TO 4%] HALOGEN (BROMINE, CHLORIDE, IODINE) IMPURITIES.

D.S.Geikhman, V.N.Romankevich and V.G.Sidyakin.

Fiz. tverdogo Tela, Vol. 1, No. 2, 218-26 (Feb., 1959). In Russian.

The electrical conductivity σ and its temperature dependence, thermo-e.m.f. α and its temperature dependence, and the concentration n and the mobility μ of the charge carriers were determined. The effect of the variation of a.c. frequency on the resistivity ρ of pure and Cl-bearing Se was also studied. Additions of Br, Cl and (to a lesser degree) I increased σ which, from 20° to

70° C, increased with rising temperature in Br-bearing Se, remaining practically constant in specimens containing Cl and I. α of Se with Br, Cl and I additions was lower than that of pure Se, was little affected by temperature in the case of Cl-bearing specimens, and increased with rising temperature in Se containing Br or I. The value of n and its temperature dependence were only slightly affected by the presence of halogens. With increasing halogen content in Se μ increased but was only slightly affected by temperature variation. The results are interpreted in terms of the contemporary concepts of the structure of Se and the existence of intergranular high-resistance barriers. M.H.Sloboda

Photoconductivity

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1676 PHOTOELECTRIC SENSITIVITY OF CHLOROPHYLL AND ITS ANALOGUES IN VARIOUS STATES.

E.Putseiko.

Dokl. Akad. Nauk SSSR, Vol. 124, No. 4, 796-9 (1959). In Russian.

The characteristic photo-effect of phthalocyanine, and its sensitization on ZnO, are studied, and it is deduced that the latter is governed by individual phthalocyanine—Mg molecules and is not related to the characteristic sensitivity of the bulk pigment. The photoelectric properties of thin layers of solvent deposited chlorophyll, phaeophytin and ethylchlorophyll on platinum bases are also investigated, films of chlorophyll in air exhibiting a small photo-e.m.f. of the order 10^{-5}-10^{-6} V for illumination at 680 mμ; this e.m.f. is increased several times when the layer is evacuated to 10^{-4} mm Hg. The sign of the charge-carriers is found to be positive. The spectral variation of photo-e.m.f., shown for thin layers of chlorophyll-(a+b) deposited on Pt from acetone solution, exhibits a wide photosensitivity band extending to 1.5 mμ and further, in addition to the main peak at 680 mμ. From a comparison with the optical absorption spectrum, it is deduced that the photo-e.m.f. occurs at the chlorophyll-Pt junction. Solvent deposited ethylchlorophyll-(a+b) on Pt exhibits a peak photo-e.m.f. at 685 mμ, corresponding to the absorption spectrum for colloidal ethylchlorophyll. Displacement of this peak to 720 mμ, when the layer is exposed to acetone vapour, is due to the formation of crystalline chlorophyll. As for chlorophyll and ethylchlorophyll, the charge carriers for crystalline layers of methylchlorophyll-(a+b) in air at room temperature are found to be positive; the peak photo-e.m.f. is at 720-730 mμ. It is deduced that the sensitization of ZnO type semiconductors by chlorophyll, with hole conduction, cannot be ascribed to electron transfer from the pigment to ZnO. The statement by Nelson (Abstr. 3135 of 1958) that chlorophyll sensitizes photoconductivity in CdS films is disputed, and no sensitization is observed for several other compounds. V.V.Zakharov

539.2 : 537.312

1677 LONG "MEMORY" EFFECT IN PHOTOCONDUCTIVITY.

A.G.Gol'dman and A.K.Kurshev.

Dokl. Akad. Nauk SSSR, Vol. 128, No. 4, 698-701 (Oct. 1, 1959). In Russian.

A considerable increase in the initial photoconductivity of polycrystalline CdS photoresistors, preliminarily exposed to visible light or to X-ray radiation, was observed. Since the induced sensitivity dimished gradually with time, the effect of preliminary excitation on the shape of the curve of photoconductivity versus time was also investigated. M.H.Sloboda

539.2 : 537.312

1678 FINE STRUCTURE OF THE SPECTRAL CHARACTERISTIC OF PHOTOSENSITIVITY OF CUPROUS OXIDE CRYSTALS.

E.F.Gross and I.Pastrnyak.

Fiz. tverdogo Tela, Vol. 1, No. 1, 162-5 (Jan., 1959). In Russian.

Photoconductivity of Cu_2O mono- and polycrystals was measured between 5300 and 6300 A at 77°K at fields from 1500 to 750 V/cm. Since the peaks of the photoconductivity curves coincided with the exciton absorption peaks (yellow and green series), they were ascribed to photo-excitation of excitons, but no details of the exciton mechanism were suggested. (See also following abstract). A.Tybulewicz

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1679 THE EFFECT OF SURFACE TREATMENT ON THE STRUCTURE OF THE PHOTOCONDUCTIVE RESPONSE SPECTRUM OF CUPROUS OXIDE CRYSTALS.

E.F.Gross and I.Pastrnyak.

Fiz. tverdogo Tela, Vol. 1, No. 5, 837-40 (May, 1959). In Russian.

The structures of absorption (A) and photoconductive response (ϕ) spectra were compared at 77°K. Only for "as grown" specimens (of all types) were these similar. Etching, polishing, air baking, etc., markedly depressed ϕ below ~ 6000 A and gave rise to maxima near 5739, 5581 and 5418 A, displaced from those in A. ϕ peaks resolved near 5739 A did not fall in a hydrogenoid series. C.H.L.Goodman

539.2 : 537.312

1680 THEORY OF PHOTOCONDUCTIVITY AND PHOTO-ELECTROMAGNETIC EFFECT IN THE PRESENCE OF ADHESION LEVELS.

A.G.Mironov.

Fiz. tverdogo Tela, Vol. 1, No. 3, 525-7 (March, 1959). In Russian.

Life-time τ of the minority charge carriers in semiconductors is often determined by a method in which the potential of the photo-magnetoelectric effect is compensated by the potential drop due to the effect of photoconductivity on d.c. current passing through the specimen. A formula for τ was derived which makes it possible to employ this method in cases when the minority carriers are captured on the adhesion levels. M.H.Sloboda

539.2 : 537.312

1681 PHOTOCONDUCTIVITY OF GALLIUM SELENIDE CRYSTALS.

R.H.Bube and E.L.Lind.

Phys. Rev., Vol. 115, No. 5, 1159-64 (Sept. 1, 1959).

Single crystals of GaSe were prepared by reaction of the elements followed by gradient freeze crystallization. Crystals as grown were p-type, probably because of Cu acceptors, with hole mobility of 15 cm^2/V sec, hole concentration of 10^{16} cm^{-3}, and acceptor ionization energy of 0.12 eV. In many ways the properties of GaSe crystals are very similar to those of ZnTe crystals. The absorption edge of GaSe is at 6310 A, corresponding to a band gap of 1.97 eV; the temperature coefficient of band gap is about -4×10^{-4} eV/deg. Insulating and photosensitive GaSe crystals can be prepared by compensating the acceptor impurities by incorporated donors from Groups VII or IV. Rectification tests indicate p-type photoconductivity. Thermal quenching of photoconductivity corresponds to an ionization energy of about 0.5 eV, whereas optical quenching corresponds to an ionization energy of about 1.0 eV; thus a large Franck—Condon shift is indicated. Below the temperature at which thermal quenching of photoconductivity occurs, the sensitivity is within the range of sensitive CdS or CdSe crystals.

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1682 DEPLETION-LAYER PHOTOEFFECTS IN SEMICONDUCTORS.

W.W.Gärtner.

Phys. Rev., Vol. 116, No. 1, 84-7 (Oct. 1, 1959).

The theory of photoconduction through the reverse-biased p—n junction in semiconductors is developed without the customary assumption that carrier generation in the junction depletion layer is negligible. Different from previous theories, the more general treatment leads to a voltage dependence of the photocurrent and its spectral distribution. When the incident light beam is modulated at frequencies comparable to the transit time through the depletion layer, a phase shift between the photon flux and photocurrent is noticed and transit-time rectification occurs.

539.2 : 537.312

1683 NEW PARALLEL PHOTOELECTROMAGNETIC EFFECT.

A.Amith.

Phys. Rev., Vol. 116, No. 2, 330-3 (Oct. 15, 1959).

A new photoelectromagnetic effect is described, in which the short-circuit current is proportional to the difference in surface recombination velocities of a pair of parallel surfaces. The surfaces are the yz planes of a slab which is illuminated in the z direction in the presence of a magnetic field in the same orientation. In addition to the primary diffusion of the generated carriers along z, there ensues a secondary flow in the transverse x direction. If the boundary conditions at the two yz planes are not identical, there results a net flow of carrier pairs toward one of these surfaces. The magnetic field B_z deflects these carriers, and a net short-circuit current passes in the y direction. Measurement of this current affords a means of probing the surface from the interior of the sample. The theory of the effect and its experimental observation are described.

539.2 : 537.312

1684 THE QUANTUM YIELD OF THE INTERNAL PHOTO-EFFECT IN ORGANIC DYES.

W.Noddack, H.Meier and A.Haus.

Z. phys. Chem. (Leipzig), Vol. 212, No. 1-2, 55-72 (1959). In German.

The primary photocurrent, resulting from short exposures of thin dye layers to light in the absorption bands, was found to saturate with voltage increase for some triphenyl methane dyes, whereas pinacyanol showed no saturation. Quantum efficiencies up to $\sim\frac{1}{3}$ were measured, the values decreasing with increasing layer thickness in the range 10^{-6} to 10^{-4} cm. Calculations of the mean free path of photoelectrons at unit field gave $\sim 0.3 \times 10^{-7}$ cm, or many times the molecular spacing at the field strengths used.

S.T.Henderson

539.2 : 537.312

1685 THE ACTION OF HYDROGEN ON THE PHOTOELECTRIC EFFECT IN ORGANIC DYES. H.Meier.

Z. phys. Chem. (Leipzig), Vol. 212, No. 1-2, 73-86 (1959). In German.

See preceding abstract. The known reduction of photocurrent in organic dyes by the presence of O_2 is also observed if H_2 is admitted to thin layers of dye at 10^{-2} mm Hg, but if the pressure is first reduced to 10^{-5} to 10^{-6} mm, H_2 increases the photocurrent. These effects of O_2 and H_2 may be shown alternately on the same sample, though dyes vary greatly: the larger the decrease under O_2, the smaller the increase under H_2. These dyes are considered to be n-type photoconductors (Abstr. 3505, 5723 of 1959), but some in which O_2 increases and H_2 decreases the photocurrent appear to be of p-type. In the n-type, dissociation of H_2 at the surface produces protons in the chemisorption layer, and electrons in a surface layer from which they can reach the conduction band.

S.T.Henderson

Thermoelectric Properties

539.2 : 537.32

1686 THE THERMAL E.M.F. OF SEVERAL THERMOELECTRIC ALLOYS. R.L.Powell and M.D.Bunch.

Bull. Inst. Internat. Froid, Annexe 1958-1, 129-35.

Describes briefly the apparatus for and gives the results of a determination of the thermal e.m.f's of Au with 2.1 atomic % Co, constantan, and Ag with 0.37 atomic % Au, against copper over the temperature range 0-300°K.

E.G.Knowles

539.2 : 537.32

1687 SOME REMARKS ON THERMOELECTRICITY. J.W.Leech and D.K.C.MacDonald.

Bull. Inst. Internat. Froid, Annexe 1958-1, 307-10.

The authors point out that irregularities in the thermoelectric behaviour of the alkali metals at low temperatures are not accounted for by existing theories. Since detailed calculations are complicated, simplified assumptions, giving good agreement with observations are advanced.

E.G.Knowles

539.2 : 537.32 : 621.317.6

1688 CONCERNING THE MEASUREMENT OF THE THERMOELECTRIC PROPERTIES OF SEMICONDUCTORS.

M.A.Kaganov, I.S.Lisker and I.G.Mushkin.

Fiz. tverdogo Tela, Vol. 1, No. 6, 988-90 (June, 1959). In Russian.

The method proposed by Harman (Abstr. 1492 of 1959) for the measurement of the parameter $z = \alpha^2\sigma/\chi$ of semiconductors is discussed (α is the thermoelectric power, σ the electrical conductivity, and χ the thermal conductivity), and a correction factor due to heat emission from the specimen and the lead wires is introduced. It is shown both theoretically and experimentally that this factor is independent of the current used. The value of the correction factor is estimated to be 1-2% and 4% for a Bi—Te—Se alloy specimen 1 cm by 0.25 cm^2 measured in vacuum and still air respectively.

D.J.Huntley

539.2 : 537.32

1689 EFFECT OF IMPURITY SCATTERING ON THE FIGURE OF MERIT OF THERMOELECTRIC MATERIALS.

R.W.Ure, Jr.

J. appl. Phys., Vol. 30, No. 12, 1922-4 (Dec., 1959).

The thermoelectric figure of merit $z = \alpha^2/\rho k$ is calculated for an extrinsic semiconductor with mixed acoustic-mode lattice scattering and ionized-impurity scattering. The result is compared with the value for pure acoustic-mode scattering. As the amount of ionized-impurity scattering is increased, the figure of merit increases by less than 10% and then falls slowly.

539.2 : 537.32

1690 INTEGRALS IN THE THERMOELECTRIC POWER OF SEMICONDUCTORS. K.Hashimoto.

Mem. Fac. Sci. Kyusyu Univ. B, Vol. 2, No. 5, 165-70 (Dec., 1958).

Some results of numerical evaluation of the integrals are presented. A combination of lattice scattering, ionized impurity scattering and neutral impurity scattering is taken into account.

P.T.Landsberg.

539.2 : 537.32

1691 THERMOELECTRIC POWER OF COLD-ROLLED PURE COPPER. R.H.Kropschot and F.J.Blatt.

Phys. Rev., Vol.116, No.3, 617-20 (Nov. 1, 1959).

The difference between the thermoelectric power of severely cold-rolled and well annealed pure copper was measured between about 8° and 320°K. The absolute thermoelectric power of annealed and cold-worked samples was determined over the same temperature range by measuring the thermoelectric power of a thermocouple formed from annealed pure copper and pure lead. The thermoelectric power of cold-rolled copper is positive relative to annealed pure copper over the entire temperature range and the effect of cold work is largest at very low temperatures where the thermoelectric power of annealed copper displays a pronounced minimum. These results are in fair agreement with recent work by Powell and by van Ooijen (unpublished).

539.2 : 537.32

1692 PHONON RELAXATION TIME AND THE VARIATION OF THERMOELECTRIC POWER OF SEMICONDUCTORS BY A MAGNETIC FIELD. J.Appel.

Z.Naturforsch., Vol. 14a, No. 9, 838-40 (Sept., 1959). In German.

Expressions are given for the differential thermoelectric power of semiconductors with a simple band structure in a strong magnetic field. The decrease of thermoelectric power with increasing field is discussed.

J.Franks

Dielectric Properties

539.2 : 537.2

1693 ON THE IONIC POLARIZATION IN COMPLEX IONIC CRYSTALS. A.E.Glauberman and I.M.Spitkovskii.

Izv. Akad. Nauk SSSR, Ser. fiz., Vol. 22, No. 3, 260-2 (1958). In Russian. English summary: PB 141041T-3, obtainable from Office of Technical Services, U.S. Dept. of Commerce, Washington, D.C., U.S.A.

A method of calculating the ionic polarization in a crystal having an arbitrary number of ion species and of arbitrary structure is presented. Ionic polarizabilities are derived from the individual displacements and the effective local fields.

K.W.Plessner

539.2 : 537.2

1694 SWITCHING MECHANISM IN TRIGLYCINE SULFATE AND OTHER FERROELECTRICS.

E.Fatuzzo and W.J.Merz.

Phys. Rev., Vol. 116, No. 1, 61-8 (Oct. 1, 1959).

The reversal of the spontaneous polarization in a ferroelectric crystal is governed by two mechanisms: the nucleation of new domains and the growth of these domains by domain wall motion. The switching properties of triglycine sulphate were investigated as a function of applied electric field, temperature, and thickness of the samples. It is proposed that at low fields nucleation is the slower mechanism and hence dominates the switching process while at high fields domain wall motion determines the rate of switching. The former process leads to an exponential dependence of switching time on applied electric field and the latter to a linear dependence. A model for the nucleation and domain wall motion is treated mathematically and is compared with experimental observations. The shape of the switching current pulse was found to yield much information. The shape depends strongly on the applied electric field and is correlated with the nucleation time as well as the domain wall motion time. The asymmetry of the pulse increases with decreasing field and can be associated with the interaction between domains and domain nuclei. This interaction in various ferroelectrics is discussed and its relation to the switching is considered.

539.2 : 537.2 : 538.2

1695 SYMMETRY OF FERROELECTRICS. N.N.Neronova and N.V.Belov.

Dokl. Akad. Nauk SSSR, Vol. 129, No. 3, 556-7 (Nov. 21, 1959). In Russian.

Ferromagnetic substances belong to one of 31 Shubnikov black and white point groups (Abstr. 444-6 of 1958). Ferroelectrics are analogous, except that the characteristic vector is usually polar instead of axial. The 31 point groups to which ferroelectrics and ferromagnetics may belong are tabulated in international symbols. See also Abstr. 8254 of 1957. R.F.S.Hearmon

539.2 : 537.2

1696

MODEL FOR SWITCHING AND POLARIZATION REVERSAL IN COLEMANITE.

H.H.Wieder.

J. appl. Phys., Vol. 31, No. 1, 180-7 (Jan., 1960).

The characteristic properties of the displacement current transients obtained from ferroelectric colemanite crystals during polarization reversal are presented in detail. A phenomenological and semiempirical model of the switching mechanism is proposed. The model yields good agreement with the switching current dependence upon time, field amplitude and ambient temperature. It is based upon random nucleation followed by extensive sidewise displacement of the nucleated 180° domains. A model based upon three dimensional growth of nucleated domains is shown to be in poor agreement with experiment.

539.2 : 537.2

1697

INFLUENCE OF ADMIXTURES ON THE ELECTRIC PROPERTIES OF RUTILE.

Ya.M.Ksendzov.

Izv. Akad. Nauk SSSR, Ser. fiz., Vol. 22, No. 3, 237-48 (1958). In Russian. English summary : PB 141041T-3, obtainable from Office of Technical Services, U.S. Dept. of Commerce, Washington, D.C., U.S.A.

Abnormally high values of ϵ in 'pure' TiO_2 are believed due to lattice defects caused by Nb and Ta oxide impurities. The number of surplus valence electrons and the conductivity vary exponentially with temperature and inversely to the oxygen pressure. The rise of ϵ with impurity concentration and the dependence on frequency depend on interaction of electrons of the impurity centres. Polarization caused by impurity centres is a resonance mechanism, the resonance frequency corresponding to the frequency of electron exchange between impurity centres and depends on the concentration of impurity and the orbit radius of the electrons. J.H.Mason

539.2 : 537.2

1698

FERROELECTRIC "SUBSTITUTIONAL—DEFECT" SOLID SOLUTIONS.

G.A.Smolenskii, V.A.Isupov and A.I.Agranovskaya.

Fiz. tverdogo Tela, Vol. 1, No. 10, 1573-82 (Oct., 1959). In Russian.

Briefly surveys recent work on solid solutions of this type and classifies the solutions into two main categories. After a brief mention of the methods of preparing the samples, experimental data are quoted at some length; the data refer mainly to ϵ and $\tan\delta$ as functions of temperature for different combinations in the systems $BaTiO_3-La_{2/3}TiO_3$, $BaTiO_3-BaO:NiO$, $BaTiO_3-Ba_{0.5}NbO_3$. Other systems referred to are $BaTiO_3-Ba_{0.5}TaO_3$, $BaTiO_3-WO_3$, $BaTiO_3-BaO:AlO_{1.5}$, $BaTiO_3-NaTiO_{2.5}$. It is concluded that: (1) the solid solutions investigated fall into two groups, in the first of which (e.g. $BaTiO_3-La_{2/3}TiO_3$) the maximum of ϵ at the Curie point is preserved even with high contents of the second component, whereas in the second group (e.g. $BaTiO_3-BaO:NiO$) ϵ is "suppressed" with relatively low contents of the second component; (2) the properties of solid solutions of the second group can be explained by excitation of electrons and holes localized near vacant nodes in the crystal lattice. D.E.Brown

539.2 : 537.2

1699

ON THE DEPENDENCE OF THE SWITCHING TIME OF BARIUM TITANATE CRYSTALS ON THEIR THICKNESS.

M.E.Drougard and R.Landauer.

J. appl. Phys., Vol. 30, No. 11, 1663-8 (Nov., 1959).

The dependence of switching rate on the crystal thickness has been measured by Merz and explained by him in terms of a surface layer which has a low dielectric constant, and is about 10^{-4} thick. While not explicitly stated in Merz' original arguments, the layer must have a reversible polarization. If a layer without a reversible polarization is assumed, instead, and the discontinuity of the normal component of polarization at the interface between the layer and the bulk is taken into account, then a much thinner layer (~ 1 atomic thickness) will explain the thickness dependence. This layer can be taken to be very lossy, so that it has a relaxation time (for the disappearance of electric fields) short compared to the switching time, and yet the layer will still be completely effective in slowing down domain wall motion.

539.2 : 537.2

1700

DOMAIN PROCESSES IN LEAD TITANATE ZIRCONATE AND BARIUM TITANATE CERAMICS.

D.Berlincourt and H.H.A.Krueger.

J. appl. Phys., Vol. 30, No. 11, 1804-10 (Nov., 1959).

The amount of 90° reorientation during poling was determined from mechanical strains measured during the poling process. With tetragonal lead titanate zirconate 53% of the possible 90° reorientation occurred during poling, but this figure dropped to 44% upon removal of the poling field. With barium titanate the figures are only 17% and 12%, respectively. Comparison of the polarization of poled polycrystalline barium titanate with that for single crystals indicates that 180° reorientation is virtually perfect. Application of very high compressive stress parallel to the polar axis causes 90° switching of nearly all aligned domains, and, therefore, removes virtually all polarization. Curves of released charge as function of mechanical strain are nearly linear, but curves of released charge as function of stress are strongly nonlinear. Application of high compressive stress perpendicular to the polar axis also causes 90° domain reorientation and a reduction in the total polarization of the ceramic. This domain reorientation may be interpreted as a shift of the polar axes of some domains into a position more closely corresponding to the plane of cross expansion, and typically the total electric moment is reduced by less than 10%. High electric stress causes 180° as well as 90° domain reorientation. With prepoled specimens d.c. fields in the same direction as the poling field cause 90° switching, while reverse d.c. fields cause both 90° and 180° reorientation, with the latter predominating.

539.2 : 537.2

1701

FURTHER EXPERIMENTS ON THE SIDEWISE MOTION OF 180° DOMAIN WALLS IN $BaTiO_3$.

R.C.Miller and A.Savage.

Phys. Rev., Vol. 115, No. 5, 1176-80 (Sept. 1, 1959).

For previous work, see Abstr. 4555 (1959). Techniques have been developed to extend the measured electric field dependence of the sidewise 180° domain-wall velocity in liquid-electroded $BaTiO_3$ crystals. The wall velocity data now cover about eight decades of velocity. The wall velocity is given by $v_\infty \exp(-\delta/E)$, where δ is found to increase slightly with field. The temperature dependence of v was measured over a limited temperature range and the data show that δ varies with temperature faster than T^{-1}. The shapes and orientations of the reversed domains are field dependent. As the electric field is increased, the approximately square reversed domains observed in the low-field region go over into octagonal domains. At still higher fields, approximately square domains rotated by 45° about the ferroelectric axis with respect to the low-field domains are observed. Several of the important features of the sidewise wall motion are consistent with a nucleation-controlled model which is currently under investigation.

539.2 : 537.2

1702

VARIATION IN FERROELECTRIC CHARACTERISTICS OF LEAD ZIRCONATE TITANATE CERAMICS DUE TO MINOR CHEMICAL MODIFICATIONS.

R.Gerson.

J. appl. Phys., Vol. 31, No. 1, 188-94 (Jan., 1960).

Lead zirconate titanate ceramics with certain 3- or 5-valent additions (lanthanum, neodymium, tantalum, and niobium) are found to be characterized by low aging of electrical and mechanical properties, a well-defined hysteresis loop, and by high electrical and mechanical losses. Experimental investigations are reported on plain lead zirconate titanate and on a low-aging niobium modification. The experiments included an electron microscope study of the ceramics and a number of electrical measurements. As a result of the study, the changed properties of the substituted material have been explained as being due to domain wall motion under low electric field. The results of electrical measurements supporting this conclusion, and a hypothesis accounting for the effects in terms of lattice vacancies, are presented. The 3- or 5-valent additives described in the foregoing also cause greatly increased volume resistivity in the ceramic. This has not been satisfactorily explained.

539.2 : 537.2

1703

ASYMMETRIC HYSTERESIS LOOPS AND THE PYROELECTRIC EFFECT IN TRIGLYCINE SULFATE.

A.Savage and R.C.Miller.

J. appl. Phys., Vol. 30, No. 11, 1646-8 (Nov., 1959).

Dynamic pyroelectric techniques have been used to study single crystal triglycine sulphate hysteresis loops at room temperature. An apparent polarization bias is observed and is similar to that reported earlier for $BaTiO_3$. The apparent polarization bias can be shifted with the application of a d.c. electric field. When precautions are taken to eliminate electrode-edge effects, the pyroelectric hysteresis loops are always symmetric. The apparent polarization bias is ascribed to electrode-edge effects as in the case of $BaTiO_3$.

539.2 : 537.2

1704 DIPOLE RELAXATION OF DEFECT CENTRE COMPLEXES IN DOPED SILVER HALIDES.

M.Höhne.

Z.Naturforsch., Vol.14a, No.8, 760-2 (Aug., 1959). In German.

Ag Br crystals were doped with Ag_2Se, Ag_2S, Ag_2Te and Ag_2O and the dielectric loss factor determined at low temperatures. Two peaks were obtained, the position of which depended on the added impurity. The lower temperature peak is due to an impurity ion—Ag ion interstitial association, the higher temperature peak is due to an impurity ion—Br ion vacancy association. J.Franks

539.2 : 537.2

1705 INVESTIGATION OF THE ELECTRIC AND OPTICAL PROPERTIES OF POLYMERS FORMING ELECTRETS.

K.V.Filippova.

Izv. Akad. Nauk SSSR, Ser. fiz., Vol. 22, No. 3, 343-51 (1958).
In Russian. English summary: PB 141041T-3, obtainable from Office of Technical Services, U.S. Dept. of Commerce, Washington, D.C., U.S.A.

Electrets formed from polymethylmetacrylate are shown to be optically anisotropic. The anisotropy increases almost linearly with the forming field, but there is a threshold forming time of 2 to 3 h at elevated temperature, below which little anisotropy is induced at any field strength. The character of the electret changes with the mode of formation in a manner which is not correlated with the optical anisotropy, and the optical and electrical properties also relax in a different manner. It is suggested that thermally activated reorientation of the polar $OCOCH_3$ groups is primarily responsible for both effects, but that more of the polymer chain is involved in the optical change, thus accounting for the differences in forming and relaxation. L.E.Cross

539.2 : 537.2

1706 ON THE DEDUCTION OF THE DISTURBANCE CRITERION OF DIELECTRIC STRENGTH IN IONIC CRYSTALS FROM THE KINETIC EQUATION.

V.A.Chuenkov.

Izv. Akad. Nauk SSSR, Ser. fiz., Vol. 22, No. 4, 369-76 (1958).
In Russian. English summary: PB 141041T-4, obtainable from Office of Technical Services, U.S. Dept. of Commerce, Washington, D.C., U.S.A.

By means of a rigorous solution of the kinetic equation, the critical field strength at which the dielectric strength is disturbed is calculated. The theory agrees with experimental data for alkali-halide crystals, and the dependence of the critical field on various lattice parameters is deduced. The ionization of impurities affects the dielectric strength only if their concentration exceeds $10^{18}/cm$. R.C.Kell

539.2 : 537.2

1707 THE DEPENDENCE OF DIELECTRIC STRENGTH OF THE ALKALI-HALIDE CRYSTALS KBr AND KCl ON TEMPERATURE.

E.A.Konorova and L.A.Sorokina.

Izv. Akad. Nauk SSSR, Ser. fiz., Vol. 22, No. 4, 401-3 (1958).
In Russian. English summary: PB 141041T-4, obtainable from Office of Technical Services, U.S. Dept. of Commerce, Washington, D.C., U.S.A.

The variation of the dielectric breakdown strength with changing temperature was shown experimentally to contain a maximum for constant voltage pulses of duration longer than 10^{-6} seconds, but not for shorter pulses. It was postulated that the reduction in dielectric strength at low and high temperatures may be accounted for by the occurrence of space charges: at low temperature a negative space charge forms at the cathode due to cold emission, and a positive space charge forms at the anode at high temperature caused by the conductivity in the crystal. At some intermediate temperature the space charges may cancel giving a high breakdown strength. It is deduced that the time of formation of the ion space charge must be greater than 10^{-6} seconds. W.G.Townsend

539.2 : 537.2

1708 TEMPERATURE DEPENDENCE OF DIELECTRIC STRENGTH OF IONIC CRYSTALS IN AN ELECTRIC DISRUPTION.

V.D.Kuchin.

Izv. Akad. Nauk SSSR, Ser. fiz., Vol. 22, No. 4, 404-7 (1958).
In Russian. English summary: PB 141041T-4, obtainable from Office of Technical Services, U.S. Dept. of Commerce, Washington, D.C., U.S.A.

Measurements of the dielectric strengths of NaCl, KCl, KBr and KI over a temperature range -130 to 150°C at constant voltages with pulse durations from 10^{-4} to 10^{-8} seconds are given. In most cases the graphs of dielectric strength versus temperature show a maximum, but for the shortest pulses the breakdown strength is constant and very much greater than for the longer pulses. It is postulated that this is caused by the mechanical destruction of the dielectric which takes place when sufficiently high voltages are applied. The paper stresses the need for considering the duration of the voltage application when making theoretical calculations of the temperature dependence of dielectric strength.
W.G.Townsend

539.2 : 537.2

1709 ON THE TEMPERATURE DEPENDENCE OF THE PULSED DIELECTRIC STRENGTH OF SOME POLYCRYSTALLINE DIELECTRICS.

E.A.Konorova, V.V.Krasnopevtsev and G.I.Skanavi.

Izv. Akad. Nauk SSSR, Ser. fiz., Vol. 22, No. 4, 408-13 (1958).
In Russian. English summary: PB 141041T-4, obtainable from Office of Technical Services, U.S. Dept. of Commerce, Washington, D.C., U.S.A.

The temperature variation of the dielectric breakdown strength (E_{br}) of polycrystalline titanates of zinc, barium and calcium was measured using pulsed voltages. E_{br} was found to be independent of the pulse duration but a correlation was shown between the temperature variations of the dielectric permittivity ϵ, and E_{br}. Analysis of the results in terms of existing theory is impossible owing to the complex crystal structure. Work on monocrystals should show the true temperature dependence of dielectric strength on dielectric permittivity. W.G.Townsend

539.2 : 537.2

1710 INVESTIGATION OF THE ELECTRIC BREAKDOWN OF ROCK SALT CONTAINING COLOUR CENTRES.

A.A.Vorob'ev and G.A.Vorob'ev.

Izv. Akad. Nauk SSSR, Ser. fiz., Vol. 22, No. 4, 397-400 (1958).
In Russian. English summary: PB 141041T-4, obtainable from Office of Technical Services, U.S. Dept. of Commerce, Washington, D.C., U.S.A.

The influence of colour centres, as sources of weakly bound electrons, on the dielectric strength of halogen salt crystals was studied. The dependence of electric strength on the degree of colouring and the period of application of the voltage was noted. Colouring was achieved by means of X-radiation and it was found that for exposures to the radiation in excess of 4×10^{-7} sec the dielectric strength was lowered. W.G.Townsend

539.2 : 537.2

1711 INVESTIGATION OF THERMAL BREAKDOWN OF ROCK SALT AT CONSTANT VOLTAGE BY MEANS OF OSCILLOGRAPHIC METHODS.

G.A.Andreev.

Izv. Akad. Nauk SSSR, Ser. fiz., Vol. 22, No. 4, 415-18 (1958).
In Russian. English summary: PB 141041T-4, obtainable from Office of Technical Services, U.S. Dept. of Commerce, Washington, D.C., U.S.A.

The dielectric strength has a maximum at 40°C, then falls rapidly with increasing temperature. Above 150°C in thinner samples the dielectric strength is higher, due to better heat conduction, and the current through the samples before breakdown is smaller. A marked reduction in resistance occurs before breakdown. The energy generated before breakdown has a maximum at 200°C, probably connected with the transition from electric to thermal breakdown. R.C.Kell

539.2 : 537.2

1712 ON THE TIME LAG IN THE DISCHARGE OF IONIC CRYSTALS.

K.K.Sonchik.

Izv. Akad. Nauk SSSR, Ser. fiz., Vol. 22, No. 4, 423-6 (1958).
In Russian. English summary: PB 141041T-4, obtainable from Office of Technical Services, U.S. Dept. of Commerce, Washington, D.C., U.S.A.

The duration of the breakdown in a dielectric (which is characteristic of the specific material and the electrical conditions) can be used to obtain a value for the average velocity of propagation of the breakdown. A single square high-voltage pulse is applied across the dielectric and the breakdown time (or discharge delay time) is recorded on a high speed oscilloscope. As the time intervals are of the order of 10^{-8} second, a firm synchronization of the time base has been achieved direct from the applied high-voltage pulse,and time calibration obtained from an h.f. generator. Preliminary results on natural single crystal rock salt show that the breakdown time is reduced by increasing the applied voltage above that required to give breakdown. The time is unchanged in irradiated or illuminated samples. W.Bardsley

539.2 : 537.2

1713 ELECTRIC BREAKDOWN OF TITANIUM-CONTAINING CERAMICS WITH A DIELECTRIC PERMEABILITY OF 80.

I.E.Balȳgin.

Izv. Akad. Nauk SSSR, Ser. fiz., Vol. 22, No. 4, 427-32 (1958). In Russian. English summary: PB 141041T-4, obtainable from Office of Technical Services, U.S. Dept. of Commerce, Washington, D.C., U.S.A.

Pulsed voltages were used and a series of oscillographs are shown, from which the average breakdown voltage of 11 kV/mm is obtained. The insulating properties are hardly reduced after the first breakdown. Irreversible changes occur in the discharge channel. The breakdown strength is affected by the electrode material, and therefore dependent on the emission of electrons. The atoms are probably not in equilibrium positions, as sintering occurs below the melting point. R.C.Kell

539.2 : 537.2 : 621.372.412

1714 DETERMINATION OF PIEZOELECTRIC PROPERTIES AS A FUNCTION OF PRESSURE AND TEMPERATURE.

J.E.McKinney and C.S.Bowyer.

J. Acoust. Soc. Amer., 56-61 (Jan., 1960).

Piezoelectric data on a mixed titanate system (82.0% $BaTiO_3$, 9.1% $CaTiO_3$, 3.6% $PbTiO_3$, and 4.4% TiO_2) were obtained with an apparatus intended to measure the dynamic compressibility of materials. The calibration constant, determined from measurements on specimens of known compressibility, involves the piezoelectric and dielectric constants of the ceramics used as transducers. The method is discussed and an operating equation for the apparatus derived. Piezoelectric and dielectric constants have been measured as a function of temperature and pressure over the ranges: – 25 to 37.5°C and 0 to 1000 kg/cm². An apparent phase transition was observed near 5°C. A qualitative discussion of the results is given.

539.2 : 537.2

1715 THE EFFECT OF THE ACTIVATOR AND THE STORAGE OF RADIANT ENERGY ON THE PIEZOELECTRIC AND ELASTIC BEHAVIOUR OF CdS SINGLE CRYSTALS.

H.Gobrecht and A.Bartschat.

Z. Phys., Vol. 153, No. 5, 529-54 (1959). In German.

The mechanical damping of the thickness vibration of CdS plate crystals was measured by utilizing the piezoelectric effect. The damping was measured at the temperatures of 20 and –180° C as a function of illumination, using both visible and infrared radiation. A variety of crystals was investigated, including very pure specimens which showed little photo-conductivity, highly activated, sensitive, crystals and intermediate samples. The results show a close correlation between the state of activation of a crystal and its mechanical damping and also an interaction between illumination and damping. The results are interpreted somewhat qualitatively. A method of accelerating the ageing of quartz oscillator crystals is suggested. K.W.Plessner

OPTICAL PROPERTIES OF SOLIDS

539.2 : 535.3

1716 OPTICAL CHARACTERISTICS OF MOLECULAR CRYSTALS IN THE EXCITON ABSORPTION REGION.

A.F.Lubchenko.

Optika i Spektrosk., Vol. 5, No. 4, 404-14 (1958). In Russian.

In the weak-coupling approximation the author obtained general expressions for the extinction coefficient κ, the refractive index n and the gyration vector γ of molecular crystals in the exciton absorption region. Calculations of the dependence of n, κ and γ on the incident-light frequency were carried out for an isotropic crystal, regarded as a Debye continuum, with the Born condition for definition of ω_{max} at T=0. Dependence of n, κ and γ on the effective exciton mass in an isotropic crystal was also determined. A.Tybulewicz

539.2 : 535.3

1717 OPTICAL INVESTIGATIONS OF THE SEMICONDUCTING MIXED-CRYSTAL SERIES $In(As_yP_{1-y})$.

F.Oswald.

Z. Naturforsch., Vol. 14a, No. 4, 374-9 (April, 1959). In German.

Extends work of Folberth (Abstr. 9224 of 1955) and Weiss (Abstr. 8196 of 1956). Absorption coefficients and refractive indices were determined for n-type specimens in the series $In(As_yP_{1-y})$. The change in the energy of the forbidden band with the arsenic content (y) and the absolute temperature (T) is $E = 1.42 - 0.98y - (4.6 - 1.1y)10^{-4}\,T$ in the range $0 \leq y \leq 1$, $100^\circ K \leq T \leq 500^\circ K$. The effective electron mass and the proportion of polar binding increases monotonically from InAs through the mixed crystals to InP. G.C.Williams

539.2 : 535.3 : 539.219

1718 REFLECTIVE POWER OF Cu–Sn ALLOYS, OBTAINED BY SIMULTANEOUS CONDENSATION OF VAPOURS OF THE COMPONENTS ON A BASE.

L.Grigoresku and M.Nakhman.

Fiz. tverdogo Tela, Vol. 1, No. 5, 808-13 (May, 1959). In Russian.

Simultaneous deposition of Cu and Sn on glass at room temperature results in formation of the alloy phases corresponding to this temperature; the ϵ-phase does not appear but can be obtained by heating the alloy. A method is described which enables the determination, under reproducible conditions, of optical properties of the alloys with continuous transition from one composition to another. Optical investigation of the alloys shows the presence of intermetallic compounds and also some structural changes resulting from heating. Z.Krasucki

539.2 : 535.3

1719 TEMPERATURE DEPENDENCE OF THE ABSORPTIVITY OF COPPER IN THE NEAR INFRARED.

J.A.Rayne.

Phys. Rev. Letters, Vol. 3, No. 11, 512-14 (Dec. 1, 1959).

A beam of wavelength range 1.8-4 μ is reflected from the copper specimen to a blackened absorber; the energies absorbed by these are determined with thermocouples and auxiliary heaters, and the fraction (A) of energy absorbed by the copper calculated. A decreases with falling temperature to 0.44% at 100°K; comparison with theory shows that, at optical frequencies, electron scattering at the surface must be predominantly specular. G.F.Lothian

539.2 : 535.32

1720 OPTICAL ANISOTROPY OF TETRAGONAL BARIUM TITANATE.

W.Kinase, J.Kobayashi and N.Yamada.

Phys. Rev., Vol. 116, No. 2, 348-50 (Oct. 15, 1959).

The optical dielectric constants and the anisotropy of tetragonal barium titanate were calculated by assuming spherical symmetry for the electron clouds of its constituent atoms. An analogous calculation was carried out for lead titanate. The calculated birefringences are positive in both crystals, in contrast to the observed ones. The results are discussed.

539.2 : 535.32

1721 A SIMPLE MATHEMATICAL REPRESENTATION OF THE INFLUENCE OF FREQUENCY ON THE COMPLEX REFRACTIVE INDEX OF METALS; APPLICATION TO THE TRANSPARENCE OF ALKALI METALS TO ULTRAVIOLET RADIATION.

M.Gourceaux.

C.R. Acad. Sci. (Paris), Vol. 249, No. 15, 1338-9 (Oct. 12, 1959). In French.

The treatment applies to metallic layers of sufficient thickness to have the same optical constants as the bulk metal. Using the concept of a phase lag between the current and the applied electromagnetic field, it is shown that the transparence of alkali metals develops progressively with frequency and not abruptly, as predicted by the classical theory. B.T.M.Willis

539.2 : 535.39

1722 CHANGES IN THE OPTICAL PROPERTIES OF A THIN LAYER OF GOLD WHEN IT IS EXAMINED FIRST UNDER VACUUM AND THEN UNDER ATMOSPHERIC PRESSURE.

R.Philip.

C.R. Acad. Sci. (Paris), Vol. 249, No. 15, 1343-5 (Oct. 12, 1959). In French.

The transmission factor and extinction coefficient are unaffected by exposure to air, whereas changes occur in the reflection factors at the air–gold and quartz–gold interfaces, in the phase change for reflection at the quartz–gold interface, and in the index of refraction. However, these changes, which increase with increasing layer thickness, are less than those produced by varying the speed of formation of the evaporated layer. B.T.M.Willis

539.2 : 535.55

1723 INFRARED STUDIES OF BIREFRINGENCE IN SILICON. S.R.Lederhandler.

J. appl. Phys., Vol. 30, No. 11, 1631-8 (Nov., 1959).

Permanent and elastic strains in silicon crystals grown by the Czochralski technique have been studied by observing the crystal birefringence. These studies reveal that the presence of birefringence is related to (a) plastic deformation caused by severe thermal gradients which produce forces exceeding the crystal yield force and (b) work damage or externally applied forces. The first source of birefringence has been termed permanent strain since this appears in the crystal as grown and the birefringence pattern cannot be altered by changes in sample geometry. This characteristic is typical of a "frozen-in" strain. A strain-free sample may also be made birefringent, however, by a work damage such as surface abrasion or sand blasting. Such a birefringent pattern can be altered if the sample geometry is changed. This characteristic, of course, is typical of elastic strain. Studies made of samples both parallel and perpendicular to the direction of crystal growth revealed birefringence patterns similar to those of naturally anisotropic crystals such as calcite. The patterns indicate the formation of a pseudo-optic axis in silicon coincident with the growth direction and is caused by the uneven temperature distribution which results in predominantly uniaxial stress. Regions of tension and compression have been discovered and their respective magnitudes determined. The calculation of the "frozen-in" tension and compression stresses are based upon experimental determination of the stress-optic coefficient of silicon. Satisfactory agreement was obtained between frozen-in stress calculations and measurements of yield stress at elevated temperatures.

539.2 : 535.33

1724 OPTICAL ABSORPTION OF CdS SINGLE CRYSTALS AT THE LATTICE ABSORPTION EDGE.

K.W.Böer and H.Gutjahr.

Z. Phys., Vol. 155, No. 3, 328-31 (1959). In German.

The optical absorption of CdS at the band edge is determined by indirect band to band transitions involving phonons. At room temperature optical absorption occurs with the emission or absorption of a phonon. The characteristic phonon energy is given. J.Franks

539.2 : 535.33

1725 OPTICAL ABSORPTION OF CoO AND MnO ABOVE AND BELOW THE NÉEL TEMPERATURE.

G.W.Pratt, Jr and R.Coelho.

Phys. Rev., Vol. 116, No. 2, 281-6 (Oct. 15, 1959).

The optical absorption of single-crystal CoO and MnO both above and below the Néel temperature is reported and interpreted. The absorption spectrum in each case is similar to that found in dilute paramagnetic salts of the same ions. Tanabe and Sugano's strong-field theory (Abstr. 2591 of 1955) was used to interpret the data. In CoO the tetragonal distortion of the cubic lattice present in the antiferromagnetic phase was experimentally observed. An estimate of the strength of the tetragonal field is given. It is also found that the temperature dependence of the absorption coefficient in CoO is in accord with a second order electric dipole–phonon transition mechanism.

539.2 : 535.33

1726 THE DEPENDENCE OF THE ENERGY GAP ON COMPOSITION FOR THE SYSTEM InSb–GaSb.

V.I.Ivanov-Omskii and B.T.Kolomiets.

Dokl. Akad. Nauk SSSR, Vol. 127, No. 1, 135-6 (July 1, 1959). In Russian.

The position of the infrared absorption edge was measured as a function of composition, using a transmission method and a double-beam spectrometer. The samples, of thickness 100μ, were prepared by zone-levelling and their composition was determined from the lattice parameters by the use of Vegard's law. The size of the energy gap varies monotonically but nonlinearly with composition. The results were corrected for the difference between room temperature and 0°K, but do not agree with those of Blakemore (Abstr. 3271 of 1957). M.G.Priestley

539.2 : 535.33

1727 OPTICAL ABSORPTION IN PURE SINGLE CRYSTAL InSb AT 298° AND 78°K.

S.W.Kurnick and J.M.Powell.

Phys. Rev., Vol. 116, No. 3, 597-604 (Nov. 1, 1959).

The absorption spectra of single crystal homogeneous InSb were measured in the spectral range 5 to 10 μ at temperatures of 78° and 298°K. Primary emphasis was placed on the precise determination of absorption coefficients less than 400 cm^{-1}. Absorption spectra were measured in many samples over a range of impurity concentrations: net impurity concentrations, expressed in atoms cm^{-3}, ranged from 5×10^{15} to 9.5×10^{16} in p-type samples, from 2×10^{15} to 3×10^{17} in n-type samples, as determined from Hall coefficients measured at 78°K. In general, the spectral range covered included regions where the absorption was dominated by either free-carrier absorption or valence-conduction band transitions. Free-carrier absorption in p-type InSb indicates a simple valence-band structure about k = 0, consisting of light and heavy hole bands. Free-carrier sections at 298°K are $\sigma_p = 8.65 \times 10^{-16}\,\text{cm}^2$ per hole and $\sigma_n = 0.23 \times 10^{-16}\,\text{cm}^2$ per electron (at 9 μ). Whereas the free hole absorption coefficient is roughly independent of wavelength, the free electron absorption σ_n varies as λ^2 and agrees well with the classical Zener–Drude model. The main absorption edge at both temperatures may be extended to lower absorption coefficients α by subtracting the extrapolated free carrier absorption coefficients α_c. The resultant band edge ln $(\alpha - \alpha_c)$ values when plotted against the photoenergy ($\hbar\omega$) fits a straight line. The slopes of these band edges increase at the lower temperature and decrease (either at 78° or 298°K) as the acceptor concentration in the optical sample increases. Various models previously proposed are compared with the experimental results.

539.2 : 535.33

1728 LIGAND FIELD THEORY AND THE ABSORPTION SPECTRA OF MnCl₂ AND MnBr₂. R.Pappalardo.

J. chem. Phys., Vol. 31, No. 4, 1050-61 (Oct., 1959).

Optical absorption spectra of $MnCl_2$ and $MnBr_2$ at room temperature and 78°K are reported and discussed. Parameters of electrostatic interaction and internal field are derived. Koide and Pryce's formalism (Abstr. 4873 of 1958) to compute transition probabilities is extended to ^{4}T levels. Many properties of the absorption spectra are nicely explained by the ligand field theory.

539.2 : 535.33

1729 THE OPTICAL ABSORPTION OF THALLIUM CHLORIDE. H. Zinngrebe.

Z. Phys., Vol. 154, No. 4, 495-511 (1959). In German.

The intrinsic absorption of TlCl is measured in the range 1850 to 6000 A wavelength. In the spectrum of thin evaporated films absorption bands are found at low temperatures which move to shorter wavelengths as the temperature rises. The absorption spectrum changes as the film changes to the amorphous state. From the temperature variation of the absorption edge two different absorption processes can be distinguished. An exciton band is superimposed on the band-band transition region. The long-wave absorption band is similar to that measured in semiconductors. The short-wave band is more like the exciton band of alkali halides. C.A.Hogarth

539.2 : 535.34

1730 CONTRIBUTION TO THE THEORY OF ABSORPTION AND DISPERSION OF LIGHT IN CRYSTALS.

S.I.Pekar.

Zh. eksper. teor. Fiz., Vol.36, No.2, 451-64 (1959) In Russian.

Previous work (Abstr. 5151 of 1958; 1857 of 1959) is extended to the case of a finite lifetime of the excited state of a crystal and several bands of light absorption. Absorption of light is obtained as the result of a finite lifetime of the excited state with respect to thermal transitions. For an extremely long exciton wave the dependence of its energy on the direction of propagation is determined. A general theory of longitudinal polarization waves in crystals is developed. By performing a transition to the limit of an infinite lifetime of the excited state it has been possible to obtain all of the main results of Abstr. 5151 (1958), taking into account the remarks containtained in Abstr. 1573.

539.2 : 535.33 : 539.18

1731 ABSORPTION SPECTRUM OF UF_4 AND THE ENERGY LEVELS OF URANIUM V. J.G.Conway.

J. chem. Phys., Vol. 31, No. 4, 1002-4 (Oct., 1959).

The absorption spectrum of U^{4+} was observed from 2000 A to 8 μ. All the terms that can arise from two f electrons were found. Terms were assigned to all the absorption peaks. The radial integral, F_2, is found to be 206 cm^{-1} and the spin–orbit coupling ζ_{5f} is 1870 cm^{-1}.

539.2 : 535.33

1732 INFRARED ABSORPTION FROM L·S SPLITTINGS IN Co^{2+} SALTS. R.Newman and R.M.Chrenko.

Phys. Rev., Vol. 115, No. 5, 1147-52 (Sept. 1, 1959).

A line absorption spectrum was observed at about 0.15 eV in CoO, $CoBr_2$, $CoCl_2$, and CoF_2 crystals. For the halides, the line has a complex structure. No absorption is observed in Cs_4CoCl_6 crystals. The absorption arises from transitions between various energy levels of the L·S fine structure multiplet. In CoF_2 some of the lines show changes in intensity on passing through the Néel temperature. Optical polarization effects are also observed in the CoF_2 spectrum.

539.2 : 535.33

1733 INVESTIGATION OF THE INFRARED ABSORPTION SPECTRUM DUE TO THE MINORITY CURRENT CARRIERS IN GERMANIUM. Yu.I.Ukhanov.

Fiz. tverdogo Tela, Vol. 1, No. 3, 363-7 (March, 1959). In Russian.

Absorption spectra due to injected holes in Ge were studied at room temperature and at 105°K. Two maxima (at 3.4 and 4.7 μ) were observed in the former case, in which absorption rapidly increased at $\lambda > 5.5\,\mu$, reaching a constant value at $\lambda = 9\text{-}13\,\mu$. The low temperature spectrum had one sharp maximum at $\lambda = 4\,\mu$, where absorption reached the value attained at room temperature; it decreased almost to zero on both sides of the maximum and increased rapidly in the 6-12 μ range, reaching again a value approaching that attained at room temperature. Close agreement was established between the absorption spectra due to injected current carriers in n-Ge and those due to the equilibrium carriers in p-Ge.

M.H.Sloboda

539.2 : 535.33

1734 THE ACCURACY OF DETERMINATION OF ABSORPTION CONSTANTS OF SEMICONDUCTORS IN THE INFRARED REGION OF THE SPECTRUM. F.Oswald.

Optik, Vol. 16, No. 9, 527-37 (Sept., 1959). In German.

When measuring the optical constants of substances of high refractive index, such as semiconductors, the optical conditions must be adapted to the spectral photometer in use. The optimum specimen thickness and attainable accuracy are calculated for single beam and double beam instruments. Errors due to stray light are investigated and a number of remedies are discussed. R.W.Fish

539.2 : 535.33

1735 INFRARED ABSORPTION SPECTRUM OF LITHIUM HYDROXIDE. K.A.Wickersheim.

J. chem. Phys., Vol.31, No.4, 863-9 (Oct., 1959).

The polarized infrared absorption spectrum of crystalline lithium hydroxide in the region between 2500 and 8000 cm^{-1} was obtained with a grating spectrometer. The spectrum consists in part of a strong band at 3678 cm^{-1} polarized parallel to the c axis and bracketed in a nearly symmetric manner by five pairs of side bands polarized perpendicular to the c axis and by two pairs of side bands polarized parallel to the c axis. In addition an isolated band at 7172 cm^{-1} is observed polarized parallel to the c axis. Changes in the spectrum as the sample temperature is increased from room temperature to 400°C are described. The hydrogen positions in lithium hydroxide were deduced. It is shown, using the factor group selection rules as a guide, that the spectrum can be explained as consisting of an infrared active OH stretching fundamental surrounded by binary combinations of lattice fundamentals with the infrared and Raman OH fundamentals. The band at 7172 cm^{-1} is assigned as the binary combination of the two OH fundamentals. The vibrational modes of the crystal belonging to irreducible representations of the factor group were constructed to within a good approximation. Tentative assignments of deduced lattice frequencies to constructed modes are presented. The present explanation of the lithium hydroxide spectrum is contrasted with the rotation-vibration explanation of Hexter. (Abstr. 3292 of 1959). (See also following abstract).

539.2 : 535.3

OPTICAL ABSORPTION IN α-BRASSES AT 4.2°K. See Abstr. 1542

539.2 : 535.33

1736 NEAR INFRARED SPECTRA OF CRYSTALLINE ALKAL HYDROXIDES. R.A.Buchanan.

J. chem. Phys., Vol.31, No.4, 870-4 (Oct., 1959).

The technique of melting alkali hydroxides between alkali halide plates was used to obtain the near infrared absorption spectra of LiOH, LiOD, NaOH, NaOH, NaOD, KOH, and KOD. Complicated combination band structure is observed in NaOH similar to that observed previously in LiOH, $Ca(OH)_2$ and $Mg(OH)_2$. The deuterated spectra of LiOH and NaOH indicate that both translational and librational (or rotational) modes couple to the fundamental OH^- ion vibrations. Fundamental frequencies of 3611 ± 4 and 2654 ± 2 cm^{-1} are observed for KOH and KOD, respectively. Reactions of the alkal hydroxides with certain alkali halides are observed.

539.2 : 535.33

1737 X-RAY K-ABSORPTION SPECTRA OF VANADIUM IN VARIOUS HYDRIDES, CARBIDES, NITRIDES AND BORIDES. E.A.Zhurakovskii and É.E.Vainshtein.

Dokl. Akad. Nauk SSSR, Vol. 127, No. 3, 534-6 (July 21, 1959). In Russian.

The authors refer to previous work on the absorption K-spectra of titanium and point out the need for a further investigation with similar metals. The present work was carried out with vanadium in the form of pentoxide, carbide, nitride and boride respectively. The results are analogous to those previously obtained with titanium.

T. Mulvey

539 2 : 535.33

1738 INVESTIGATION OF THE TEMPERATURE DEPENDENCE OF THE FINE STRUCTURE OF THE FUNDAMENTAL X-RAY ABSORPTION EDGE OF Fe. I.B.Borovskii and V.V.Schmidt.

Dokl. Akad. Nauk SSSR, Vol.127, No.5, 997-1000 (Aug. 11, 1959). In Russian.

Illustrates, describes and analyses this fine structure for the wavelength of 1470 X-units at temperatures of 20, 715, 795 and 950°C using a two-crystal (calcite) spectrometer with the resolving power of 11 000. The fine structure of the short-wave region and its temperature dependence are shown to be related to the excitation of plasma vibrations of the electron gas in the metal, which distorts the true form of the absorption edge. Assuming that this true form does not change during the α-γ transition, but that n/m* (ratio of the number of electrons per 1 cm^3 to the effective mass) changes so as to cause the displacement of the plasma image towards higher energies, it becomes possible to arrive at the true form of the absorption edge. F.Lachma

539.2 : 535.33 : 537.2

1739 FINE STRUCTURE OF THE X-RAY K ABSORPTION SPECTRA OF TITANIUM IN THE TITANATES OF $BaO\text{-}TiO_2$ TYPE AND ITS RELATION TO THE NATURE OF POLARIZATION OF ATOMS IN FERROELECTRIC CRYSTALS. E.E.Vainshtein, M.N.Bril' and Yu.F.Kopelev.

Dokl. Akad. Nauk. SSSR, Vol.126, No.4, 744-7, (June 1, 1959). In Russian.

Describes new measurements of the K absorption edges of $BaO.TiO_2$, $BaO.2TiO_2$ and $BaO.4TiO_2$. The relation of the fine structure to ferroelectric properties is discussed. A brief survey of the literature is given. T.Mulvey

539.2 : 535.37

1740 LUMINESCENCE AND CONDUCTIVITY INDUCED BY FIELD IONIZATION OF TRAPS. R.R.Haering.

Canad. J. Phys., Vol. 37, No. 12, 1374-9 (Dec., 1959).

When a photoconductor is illuminated at low temperatures, trapping states may be populated by electrons. If the light is then removed and an electric field is applied to the sample, these traps may be emptied by field ionization. For an electric field which increases linearly with time, the conductivity and the luminescent brightness display a sharp maximum at some field strength. It is shown that this maximum may be used to obtain the trap energy. The analysis of such field-ionization-induced maxima is very similar to the analysis of glow curves in thermoluminescence.

539.2 : 535.37

1741 A PHOSPHOR MODEL ON A QUANTUM MECHANICAL BASIS. VI. RADIATIONLESS EXCITON DESTRUCTION.

H.Stumpf.

Z.Naturforsch. Vol.14a, No.7, 659-78 (July, 1959). In German.

For Pt V, see Abstr. 12077 (1959). Methods developed in earlier papers are used to calculate the probability of recombination of electron–hole pairs at a recombination centre. The mechanism of recombination consists of the double Franck–Condon process. As several types of transition compete with each other the reaction-kinetic equations of this process must be used. These equations are simplified and the transition probabilities which occur in the equations are discussed. The latter are integrated and the mean life of the exciton is derived for radiation-free annihilation at the recombination centre. Temperature dependence and electron polarization are allowed for. Calculated numerical values for the recombination probability as a function of temperature and centre concentration are given for various types of centres in NaCl, KCl, SrS and MgO. The difference between F– and recombination centres is pointed out. R.Parker

539.2 : 535.37

1742 THE EFFECT OF RE-ABSORPTION ON THE YIELD AND DURATION OF LUMINESCENCE OF MOLECULAR CRYSTALS. I.

V.M.Agranovich and Yu.V.Konobeev.

Optika i Spektrosk., Vol. 6, No. 5, 648-58 (May, 1959). In Russian.

In previous work on phenomenological theory of excitons in molecular crystals it was implicitly assumed that reflection of luminescent light from crystal surfaces can be neglected. Experimental evidence shows that if this reflection is neglected the luminescence curves may be affected in some cases. For this reason the authors discuss here a kinetic equation which describes the distribution of excitons in a molecular crystal and which allows for internal reflection of luminescent light from crystal surfaces. For the case when the exciton diffusion coefficient is sufficiently small, exact formulae are obtained which give the quantum yield and duration of luminescence of crystals in the form of plane-parallel plates of any thickness. From the formulae which give the quantum yield the luminescence spectra can be deduced.

A.Tybulewicz

539.2 : 535.37

1743 ON THE RELAXATIONAL PROCESSES IN CRYSTAL PHOSPHORS WITH COMPLEX SPECTRA OF CAPTURE LEVELS.

K.K.Rebane.

Optika i Spektrosk., Vol. 5, No. 3, 307-11 (1958). In Russian. English summary: PB 141047T-7, obtainable from Office of Technical Services, U.S. Dept. of Commerce, Washington, D.C., U.S.A.

A theoretical paper in which general results are obtained for certain classes of band models with arbitrary spectra of electron capture levels. The model is applied to a phosphor, whose afterglow decreases according to Becquerel's law, and the law of decay of photoconductivity is deduced. It is shown that the equality of the electron capture cross-sections for all levels is an essential condition for decay under strictly equilibrium conditions, when the ratio of the population numbers of any capture levels remains constant. In one particular case the equations describing the general model can be solved exactly, the solution corresponding to afterglow decay along a second-order hyperbola. J.B.Birks

539.2 : 535.37

1744 STUDIES OF LINEAR FLUORESCENCE AND ABSORPTION OF PURE CADMIUM SULPHIDE CRYSTALS AT THE TEMPERATURE OF 4.2°K.

M.Bansi-Griio [Bancie-Grillot], E.F.Gross, E.Griio [Grillot] and B.S.Razbirin.

Optika i Spektrosk., Vol. 6, No. 5, 707-10 (May, 1959). In Russian.

CdS monocrystals were produced by sublimation and their thicknesses were $\sim 50\,\mu$ or less. A spectrograph of 4 A/mm dispersion was used to obtain the spectra at 4.2°K. The fluorescence spectrum of these crystals was linear and contained one new line (4868.2 A) in addition to those reported earlier [C.R. Acad. Sci. (Paris), Vol. 242, No. 14, April 4, (1956); Abstr. 4213 of 1957]. As before, the fluorescence was mainly blue with very feeble emission at green wavelengths. The background between 4870 and 4942 A and the fluorescence lines were polarized with the electric vector at right-angles to the optical axis of the monocrystal, suggesting a common origin for all of them. The absorption spectrum in unpolarized light had three lines (4853.1, 4857.2, 4869.1 A) whose positions were very close to the three fluorescence lines at 4856.6, 4861.4 and 4870.0 A. In the region where continuous absorption was somewhat weaker, the light which had passed through the crystal was completely polarized with the electric vector parallel to the optical axis of the crystal. The authors obtained also the fluorescence spectrum of a crystal which was not prepared by sublimation (the method of preparation is not given). This spectrum was characterized by a strong green band and a line structure in the blue region which was quite different from that observed in sublimated crystals; neither the green band nor the blue lines were polarized. See also the following abstract.

A.Tybulewicz

539.2 : 535.37

1745 THE EFFECT OF A MAGNETIC FIELD ON THE BLUE FLUORESCENCE AND ON THE ABSORPTION LINES OF SOME PURE CADMIUM SULPHIDE CRYSTALS AT THE TEMPERATURE OF 4.2°K.

E.F.Gross, E.Griio [Grillot], B.P.Zakharchenya and M.Bansi-Griio [Bancie-Grillot].

Optika i Spektrosk., Vol. 6, No. 5, 710-12 (May, 1959). In Russian.

Continuation of the work described in the preceding abstract. A CdS monocrystal prepared by sublimation (dimensions 4 mm × 2 mm × 50-60 μ) was placed between the poles of an electromagnet. A diffraction spectrograph with 1.7 A/mm dispersion was used to record the fluorescence spectrum of the crystal excited by the 3650 A line at 4.2°K. In a magnetic field of 28 000 Oe, oriented at right-angles to the optical axis of the crystal, the fluorescence lines at 4870, 4868 and 4861 A exhibited Zeeman splitting into doublets. The doublet components were polarized in the same way as the original lines, i.e. with the electric vector at right-angles to the optical axis of the crystal. No splitting was observed in magnetic field up to 28 000 Oe, oriented parallel to the optical axis of the crystal. The authors studied also the effect of magnetic fields on the absorption lines of sublimated CdS monocrystals. They found that the 4869.1 A line is broadened from 1.62 to 2.24 A by a field of 28 000 Oe (directed at right-angles to the optical axis of the crystal), indicating a possible Zeeman splitting into a doublet. A.Tybulewicz

539.2 : 535.37

1746 SOME EFFECTS OF LOW FIELDS ON LUMINESCENCE OF CdS.

C.E.Bleil and D.D.Snyder.

J. appl. Phys., Vol. 30, No. 11, 1699-702 (Nov., 1959).

The effects produced on luminescence and conductivity in pure CdS crystals by application of electric fields up to ~ 1000 V/cm are reported. A shift in the red and green cathodoluminescence peaks of ~ 0.1 A(V/cm)$^{-1}$ is observed. After application of the low fields, some crystals required over 90 min to recover their "prefield" luminescence. Fine structure in the luminescent peaks at room temperature is reported. A V–I plot shows a sublinear relation in this voltage range for several different levels of irradiation. An explanation of the observations is suggested based on self-trapping of electrons.

539.2 : 535.37

1747 MONOCHROMATICALLY EXCITED FLUORESCENCE IN RARE EARTH SALTS.

F.Varsanyi and G.H.Dieke.

J. chem. Phys. Vol. 31, No. 4, 1066-70 (Oct., 1959).

Monochromatic excitation, continuously variable in wavelength, makes it possible to analyze in detail the excitation of the fluorescence spectra of rare earth salts. This is a very sensitive method for studying the coupling of the electronic levels with the lattice vibrations. When a crystal contains several kinds of rare earth ions their fluorescence spectra are excited independently of each other.

539.2 : 535.37

1748 LUMINESCENCE LINES IN X-RAY IRRADIATED CRYSTALS OF LITHIUM FLUORIDE.

A.A.Kaplyanskii.

Optika i Spektrosk., Vol. 6, No. 3, 424-6 (March, 1959). In Russian.

Reports a discovery, at 77°K, of a luminescence line spectrum in LiF prepared from monocrystals subjected to X-ray radiation for tens of hours (only visible coloration is produced). Apart from the well-known wide red and green bands, narrow "atomic" lines were found at wavelengths from 4000 to 6000 A. These lines disappear on heating to room temperature. Their intensities vary from sample to sample (the samples were X-ray irradiated for various lengths of time) and certain lines were present in some samples but not in the others. The author suggests that these lines may be closely related to the absorption lines which were observed in

strongly coloured LiF at low temperatures by Pringsheim. (Abstr. 5475 of 1954) and Klick (Abstr. 732 of 1951), but no explanation of their origin is offered. See also following abstract.
A.Tybulewicz

539.2 : 535.37

1749 THE ORIENTATION OF CENTRES OF LUMINESCENCE LINES IN X-RAY IRRADIATED LiF CRYSTALS.

P.P.Feofilov.

Optika i Spektrosk., Vol. 6, No. 3, 426-7 (March, 1959). In Russian.

Extends Kaplyanskii's work (see preceding abstract) to measurement of the azimuthal dependence of polarization of the luminescence lines observed at 77°K in X-ray irradiated LiF. From these measurements it is deduced that the centres responsible for the lines at 5627 and 5698 A are oriented in the same way as those responsible for the wide red band, i.e. along the second-order symmetry axis of the cubic crystal of LiF. This fact, together with the position of the narrow lines near the short-wavelength edge of the red band and their occurrence only in samples with intense red emission, suggests that the narrow lines are due to F_2- or M-centres, which are also responsible for the red band. The exact nature of emission of these narrow lines and why they occur only in LiF are still open questions. A.Tybulewicz

539.2 : 535.37

1750 THE DE-EXCITING ACTION OF X-RAYS.

I.A.Parfianovich.

Optika i Spektrosk., Vol. 5, No. 5, 612-14 (1958). In Russian.

Free electrons, produced by the action of X-rays in alkali-halide phosphors, are localized both at the capture centres of the halide itself and at the activator centres. Distribution of electrons in energy levels of capture centres may be found by determining the spectrum of additional absorption due to the action of X-rays. It is found that in NaCl:Ni irradiated to saturation with X-rays neither the activator levels nor the capture levels of NaCl itself are completely filled. This is known as the de-exciting action of X-rays. The effect is due to the limited number of levels being available for localization of holes. Equal numbers of holes and electrons are created by the action of X-rays, but the number of the centres which can capture holes is smaller than the number of the electron capture centres. Once all the hole levels are filled the remaining holes recombine with free electrons preventing complete filling of the electron-capture levels. A.Tybulewicz

539.2 : 535.37

1751 EDGE AND OTHER EMISSION OF GaN.

H.G.Grimmeiss and H.Koelmans.

Z. Naturforsch., Vol. 14a, No. 3, 264-71 (March, 1959). In German.

The temperature dependence of the fluorescence has been studied both in the pure and the doped material. The doping substances used were Li, Zn and Mg. The emission band of shortest wavelength has been interpreted as due to electron-hole recombination. P.T.Landsberg

539.2 : 535.37

1752 ON THE Mn—ACTIVATED PHOSPHORS.

O.Matumura.

Mem. Fac. Sci. Kyusyu Univ. B, Vol. 2, No. 5, 175-86 (Dec., 1958).

The determination of some physical properties of manganese activated phosphors is described and the results discussed. One method of examination is by means of electron spin resonance in those phosphors for which the divalent manganese is in a nearly cubic crystalline field. The observed hyperfine structure was found to be proportional to the ionicity of the crystal bond. The uniqueness of the manganese activated phosphor is ascribed to the state of manganese in the cluster theory. K.N.R.Taylor

539.2 : 535.37

1753 ON THE POSSIBILITY OF RECOMBINATION PROCESSES IN LUMINESCENCE OF TUNGSTATES AND URANYL COMPOUNDS.

V.L.Levshin, V.B.Gutan and E.N.Karzhavina.

Optika i Spektrosk., Vol. 6, No. 3, 372-6 (March, 1959). In Russian.

The authors describe their studies of luminescence of uranyl silicate (UO_2SiO_3) and calcium tungstate ($CaWO_4$) excited with electrons or with light between -185 and +300°C. The phosphors were irradiated with a 10^{-7} A/cm², 14 kV beam of electrons for 30 minutes at -185°C. When cathodoluminescence died away completely the phosphors were heated at the rate of 10 deg/min and the resultant thermal de-excitation (thermoluminescence) curves were recorded. Electron-irradiated, thermally de-excited and subsequently photoexcited at 366 and 312 mμ, $CaWO_4$ also exhibited thermoluminescence. Photoexcitation of $CaWO_4$ which was not previously electron-irradiated, and photoexcitation of UO_2SiO_3, whether electron-irradiated or not, did not produce any thermoluminescence and the thermoluminescence intensities were of the order of several per cent compared with cathodoluminescence. The observed thermoluminescence and the hyperbolic decay of cathodoluminescence at -185°C are ascribed to disturbance of the crystal lattice by the electron beam with the resultant formation of centres at which electrons can be localized. Cathodoluminescence is due to recombination of electrons liberated from shallow levels, and thermoluminescence is due to electrons freed from deeper levels.
A.Tybulewicz

539.2 : 535.37 : 539.1.07

1754 DIRECTIONAL DEPENDENCE OF THE SCINTILLATION RESPONSE OF ANTHRACENE TO α-IRRADIATION.

P.H.Heckmann.

Z. Phys., Vol.157, No.2, 139-48 (1959).

The response depends on the direction of incidence of the particles with respect to the crystal axes. The response is maximal in the direction perpendicular to the main cleaving plane a b and minimal in the direction parallel to the axis a, the quotient of maximum and minimum response being about 1.55 at an energy of 5.3 MeV and increasing with decreasing energy of the α-particles. A formula based on simple assumptions is derived, which describes correctly the measured angular dependence.

539.2 : 535.37

1755 THE DECAY OF THE LUMINESCENCE OF ZnS:Cu, ZnS:S, ZnS:Zn AND ZnO:Zn IN THE CASE OF EXCITATION WITH 60 keV H_2^+ ION PULSES. K.H.Härdtl.

Z. Phys., Vol. 157, No. 3, 316-25 (1959). In German.

All phosphors show increasing decay times as the pulse-duration was increased. This increase can be calculated from the partial superposition of the single ion-pulses. If the pulses last longer than 3 μsec the experimental decay-time values for ZnS:Cu (5×10^{-3}), (10^{-3}) are larger than the calculated ones, which is attributed to the influence of traps; for ZnS:Cu (10^{-4}), (10^{-5}), ZnS:S, ZnS:Zn and ZnO:Zn, they are smaller, which might be explained by partial coincidence of excitation canals. ZnS:Cu, ZnS:S and hexagonal ZnS:Ag show more rapid decay in the short wavelength region of their emission spectra compared with the longer wavelength region. Measurements with α-particles were made for comparison.

539.2 : 535.37

1756 MEASUREMENT OF THE LUMINESCENCE DECAY-TIMES OF INORGANIC FLUORESCENT MATERIALS IN THE CASE OF ION EXCITATION. A.Scharmann.

Z. Phys., Vol. 157, No. 3, 301-15 (1959). In German.

An experimental set-up is described measuring decay-times down to about 10^{-7} sec. The luminescence decay of $MgWO_4$, $ZnWO_4$, $CdWO_4$, $CaWO_4$, CsI:Tl and NaCl:Ag proved to be exponential and independent of wavelength. Due to high excitation density quenching of luminescence occurs at the beginning of the decay. Hence decay is more rapid as ion mass is increased. Changing ion energy between 10 and 60 keV shows no measurable influence on decay time. Luminescence of ZnS:Cu decreases hyperbolically, decay depending on ion energy, ion-pulse duration, and ion mass. The blue emission band of ZnS:Mn shows similar behaviour. The orange-coloured Mn-emission band of ZnS:Mn shows exponential decrease and strong dependence on concentration.

539.2 : 535.37

1757 FORMAL ANALYSIS OF THE THEORY OF TWO-STAGE EXCITATION OF PHOSPHORESCENCE AND PHOTOCONDUCTIVITY. III. COMPARISON OF THE THEORY WITH EXPERIMENT (Zn:Cu EMISSION). N.A.Tolstoi.

Optika i Spektrosk., Vol. 6, No. 5, 665-71 (May, 1959). In Russian.

For Pts I and II see Abstrs. 4221 of 1957 and 661 of 1960. In their earlier work the author and Shatilov discussed the possibility of two-stage excitation of sulphide phosphors and gave a formal analysis of the steady-state and relaxation processes in the two-stage theory. The present paper describes a comparison of the two-stage theory with the experimentally determined steady-state and relaxation properties of ZnS:Cu. It was found that the values of the parameters which lead to agreement between the theory and experiment were the same for the steady-state and relaxation properties. The steady-state emission and the initial stages of phosphorescence decay of ZnS:Cu phosphors are essentially "pseudomonomolecular" processes, while the later stages of the afterglow suggest a "bimolecular" mechanism. A.Tybulewicz

539.2 : 535.37

1758

CONFIGURATION INTERACTION IN ALKALI HALIDE PHOSPHORS.

R.S.Knox.

Phys. Rev., Vol. 115, No. 5, 1095-106 (Sept. 1, 1959).

It is shown that excited-state wave-functions of free activator ions do not provide a completely adequate basis for a quantitative theory of the luminescence of alkali halides activated by heavy metals. It is proposed that better zero-order wave-functions may be obtained by allowing interaction between different types of states of excitation, and as a practical example of an electronic configuration which can interact with excited activator configurations, the electron transfer states of the Seitz model are discussed in detail. These states have generally been ruled out because of the absence of a halogen-like doublet in the phosphor absorption spectra, but a closer analysis shows that the doublet character of the activator atom is of equal importance. Neither of the doublets is expected to appear explicitly in the spectra. A numerical estimate of the coupling between an excited activator 6s6p state and a typical electron transfer state indicates the possibility of strong interaction between these configurations. It is concluded that the Seitz model is capable of explaining recent experiments on excitation bands, polarization effects, and lattice structure dependence of absorption spectra, provided that more emphasis is placed on electron-transfer states or other excited states of the host crystal which can interact with excited activator configurations.

539.2 : 535.37

1759

MEASUREMENT OF THE LUMINESCENCE AND DARKENING OF GLASSES DURING THEIR IRRADIATION IN A NUCLEAR REACTOR.

G.Ya.Vasil'ev, A.F.Usatȳi, Yu.S.Lazurkin and A.A.Markov.

Dokl. Akad. Nauk SSSR, Vol. 125, No. 6, 1219-22 (April 21,1959). In Russian.

Describes an experimental set-up enabling the luminescence and darkening of transparent (vitreous) materials placed in a nuclear reactor to be measured simultaneously. The materials tested were: fused silica (3 specimens of different kinds), Pyrex glass, cerium glass, polystyrene and polymethyl methacrylate. Three graphs show: (1) the dependence of the luminescence brightness on the differential dose; (2) the dependence of optical density on the time and on differential dose, and (3) the dependence of transmittance of Ce glass on the time of irradiation. It appears that, in the materials tested, there exist at least two mechanisms of darkening, one of which is caused by the formation of centres of coloration with a small time constant and is related to the magnitude of differential dose (the centres light up after 10 - 40 min), while the other is caused by the formation of much more stable centres, the darkening in this case being often proportional to the integral dose. F.Lachman

539.2 : 535.37

1760

DEPENDENCE OF THE LUMINESCENCE YIELD OF α- AND γ-EXCITED CsI:Tl CRYSTALS ON THE CONCENTRATION OF Tl.

Yu.A.Tsirlin, S.N.Komnik and L.M.Soifer.

Optika i Spektrosk., Vol. 6, No. 3, 422-4 (March, 1959). In Russian.

Reports the dependence of the luminescence quantum yield of CsI:Tl excited with either α-particles from Po^{210} or γ-rays from Cs^{137} on the amount of Tl; the latter was varied from 0.005 to 0.5 wt.%. The α-yield reaches saturation at about 0.1% Tl. The γ-yield has a maximum at 0.01 - 0.03% Tl and falls slowly with further increase of the Tl concentration. The ratio of the α-particle to γ-ray yields is maximum ($I\alpha/I\gamma = 0.55$) at about 0.1% Tl.
A.Tybulewicz

539.2 : 535.37

1761

STUDIES OF CATHODOLUMINESCENCE. I.

D.Hahn and K.Lertes.

Z. Phys., Vol.156, No.3, 425-35 (1959). In German.

New studies of the temperature dependence of cathodoluminescence indicate maxima (similar to glow curve peaks) on warming the phosphor which are related to variations in the electron excitation density. The variations arise from pressure changes in the tube caused by condensation and absorption of gases and vapours on the phosphor. The emission efficiency of the cathode is also modified. Oxide coated cathodes are more affected than tungsten cathodes. The effects disappear with improvement in vacuum. G.F.J.Garlick

539.2 : 535.37

1762

STUDIES OF CATHODOLUMINESCENCE. II.

H.Gobrecht, H.Nelkowski and D.Hofmann.

Z. Phys., Vol.156, No.4, 657-66 (1959). In German.

For Pt I see previous abstract. The temperature dependences of cathodoluminescence and of thermoluminescence after cathode ray excitation were investigated for various phosphors. Differences between curves during heating and cooling were very small except at low excitation levels and then can be explained by the action of trapped electrons. The variation of emission with temperature is specific to the particular phosphor. G.F.J.Garlick

539.2 : 535.37 : 539.27

1763

EXTENSION OF THE SCANNING MICROSCOPE TECHNIQUE TO THE OBSERVATION OF FLUORESCENT MATERIALS.

R.Bernard, F.Davoine and P.Pinard.

C.R. Acad. Sci. (Paris), Vol. 248, No. 18, 2564-6 (May 4, 1959). In French.

A scanning electron microscope has been used to observe cathodoluminescence and secondary electron emission simultaneously. The emitted light is focused on a photomultiplier, and the amplified signal from this tube used to modulate the intensity of the beam of a cathode ray oscillograph sweeping in synchronism with the exciting electron beam. The device is being developed to study the localized emission of cathodoluminescent materials. I.Cooke

539.2 : 535.37

1764

THE DEPENDENCE OF THE BRIGHTNESS OF ELECTROLUMINESCENCE ON VOLTAGE.

V.S.Trofimov.

Optika i Spektrosk., Vol. 4, No. 1, 113-15 (Jan., 1958). In Russian. English summary PB 141047T3, obtainable from Office of Technical Services, U.S. Dept. of Commerce, Washington D.C., U.S.A.

The 50 c/s electroluminescence of ZnS:Cu was studied in a special cell accommodating only a single layer of $\sim 5\ \mu$ crystals. This enabled the actual field in the crystals to be determined in the region where brightness varied as $\exp(-1/V)$, V being the applied voltage (Abstr. 3643 of 1956). Electroluminescence was observed with actual fields as low as 5×10^4 V/cm, suggesting that impact ionization can set in long before breakdown of the crystal, and that localized exhaustion regions (Abstr. 6953 of 1955) are unnecessary.
C.H.L.Goodman

539.2 : 535.37

1765

ELECTROLUMINESCENCE AT LOW VOLTAGES.

W.A.Thornton.

Phys. Rev., Vol. 116, No. 4, 893-4 (Nov. 15, 1959).

Electroluminescence occurs in activated ZnS thin films at 1.5 V r.m.s. (peak voltage 2.2 V) corresponding to electron energies less than the band gap (3.8 eV) and less than the mean energy (2.6 eV) of the photons emitted. The light emission decreases by 10^4 between 2.0 and 1.5 V r.m.s. and shows no tendency toward a threshold, nor does its spectral character change at low voltage. This behaviour suggests that electroluminescence does not depend upon collision ionization but perhaps on carrier injection or free electron temperature.

539.2 : 535.37

1766

ELECTROLUMINESCENCE AT POINT CONTACTS IN CUPROUS OXIDE AND THE MOBILITY OF Cu^+ IONS AT ROOM TEMPERATURE.

R.Frerichs and I.Liberman.

Phys. Rev. Letters, Vol. 3, No. 5, 214-15 (Sept. 1, 1959).

Observations of room-temperature electroluminescence of Cu_2O were used to measure the very small mobility (5×10^{-10} cm^2/V sec) of Cu^+ ions. Cu^+ vacancies involved in the emission are moved from the Zn cathodes, where the emission occurs, to the Pt anodes by the same field which produces the electroluminescence. J.B.Birks

539.2 : 535.37

1767

INVESTIGATION OF THE ELECTROLUMINESCENCE AND PHOTOLUMINESCENCE SPECTRA OF PHOSPHORS ACTIVATED WITH RARE-EARTH ELEMENTS.

V.E.Oranovskii and Z.A.Trapeznikova.

Optika i Spektrosk., Vol. 5, No. 3, 302-6 (1958). In Russian.

English summary: PB 141047T-7, obtainable from Office of Technical Services, U.S. Dept. of Commerce, Washington, D.C., U.S.A.

The phosphors studied were ZnS:Er,Cu; ZnS:Nd,Cu; ZnS:Er,Cu,Mn; with 4.6×10^{-4} gram -atoms/mole of Cu, 2.3×10^{-4} gram-atoms/mole of Er or Nd, and 4.3×10^{-3} gram-atoms/mole of Mn. The presence of Mn produced a strong band characteristic of Mn, a major increase in brightness of Er emission, and the appearance of the red lines of Tm (impurity in Er). Electroluminescence and photoluminescence spectra were measured under similar conditions. It is concluded that the centres responsible for the two types of emission are the same, and are similarly distributed throughout the lattice; that the emission is mainly due to low-energy "thermal" electrons; and the effective volume active in electroluminescence is about 7% of the volume active in photoluminescence. J.B.Birks

539.2 : 535.37

1768 ON THE INFLUENCE OF INFRARED IRRADIATION IN THE QUENCHING REGION ON THE THERMALLY AND ELECTRICALLY EXCITED GLOW CURVES OF SINGLE CRYSTALS OF CdS. K.W.Böer, U.Kümmel and H.Lange.
Z. phys. Chem. (Leipzig), Vol. 210, No. 3-4, 136-43 (March, 1959).

It is found that quenching radiation reduces the "conductivity glow curve" intensity in a way that can only be explained as due to recombination of trapped electrons with positive holes.
G.F.J.Garlick

539.2 : 535.37

1769 THERMOLUMINESCENCE OF VITREOUS GERMANIUM OXIDE CONTAINING ALUMINIUM IMPURITY.
V.C.Canina and S.Cohen.
C.R. Acad. Sci. (Paris), Vol. 249, No. 9, 919-21 (Aug. 31, 1959).
In French.

The material was excited to saturation at room temperature under a low pressure Hg lamp, then slowly heated. Incorporation of up to 5% Al greatly increased the thermoluminescence, and the peak emission moved from 50° to 75°C over the same range. Devitrification or chemical reduction reduced the effect. A marked absorption band at 2450 A in pure GeO_2 is removed by the Al additions.
S.T.Henderson

MAGNETIC PROPERTIES OF SOLIDS

539.2 : 538.2

1770 THE MAGNETIC SUSCEPTIBILITY OF BISMUTH TELLURIDE. R.Mansfield.
Proc. Phys. Soc., Vol. 74, Pt 5, 599-603 (Nov., 1959).

Measurements of the susceptibility of Bi_2Te_3 over the temperature range 100° to 600°K, with magnetic field parallel ($\chi_{\parallel}$) and perpendicular ($\chi_{\perp}$) to the c axis, are reported. Bi_2Te_3 is diamagnetic and $\chi_{\parallel}$ has the larger algebraic value. The contributions to the susceptibility from the core and valence electrons, free carriers and impurities are discussed, and it is suggested that the effect of the impurities is negligible, the free carriers give rise to a paramagnetic contribution and the main contribution is from the core and valence electrons.

539.2 : 538.2

1771 MAGNETIC SUSCEPTIBILITY OF InSb.
R.Bowers and Y.Yafet.
Phys. Rev., Vol. 115, No. 5, 1165-72 (Sept. 1, 1959).

The magnetic susceptibility of n-InSb was measured for a range of extrinsic carrier densities extending from 10^{16} to 6×10^{18} cm^{-3}. Measurements were made in the temperature range 300° to 1.3°K. The degenerate conduction electron susceptibility was determined from the data. The deviation of the conduction band from parabolic form is clearly exhibited in the susceptibility. A theoretical analysis was made using Kane's band-structure calculation. The mixing of the conduction and valence bands resulting from the magnetic field is treated exactly. Consideration of these two bands alone will not explain the dependence on concentration of the observed susceptibility, at the higher carrier densities, higher bands are important and a perturbation-theoretical treatment of these indicates that the observed susceptibility is consistent with Kane's model. (See also Abstr. 154 of 1960).

539.2 : 538.2

1772 THE TEMPERATURE BEHAVIOR OF THE MAGNETIC SUSCEPTIBILITY OF InAs AND InSb.
G.Römelt, D.Geist and W.Schlabitz.
Z. Naturforsch., Vol. 14a, No. 10, 923-4 (Oct., 1959). In German.

Measurements at 90° and 295°K on specimens of InAs with different carrier concentrations show a maximum in the magnitude of the diamagnetic susceptibility at about $n = 4 \times 10^{18}$ cm^{-3}. At 90°K, the magnitude of the susceptibility is between 3% and 0.5% greater than at 295°K depending on n. Less extensive results are presented for InSb. A.J.Manuel

539.2 : 538.2

1773 EFFECT OF UNIAXIAL ELASTIC DEFORMATIONS ON THE MAGNETIC PROPERTIES OF ZINC CRYSTALS AT LOW TEMPERATURES. B.I.Verkin and I.M.Dmitrenko.
Zh. eksper. teor. Fiz., Vol. 35, No. 1 (7), 291-3 (July, 1958).
In Russian. English translation in: Soviet Physics - JETP (New York), Vol. 35 (8), No. 1, 200-2 (Jan., 1959). English Summary: PB 141052T-5, obtainable from Office of Technical Services, U.S. Dept. of Commerce, Washington, D.C., U.S.A.

A technique is described for applying both tension and compression to zinc crystals. The compression (100 kg/cm^2) increases the period of the susceptibility oscillations by ~ 5% whilst the tension (20 kg/cm^2) decreases the period by about 3%. The amplitude of the oscillations is reduced but the changes are reversible. D.J.Oliver

539.2 : 538.2

1774 DIAMAGNETISM AND INTERATOMIC BONDS IN MOLECULES AND NON-METALLIC CRYSTALS.
Ya.G.Dorfman.
Zh. eksper. teor. Fiz., Vol. 35, No. 2 (8), 533-5 (Aug., 1958).
In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 35 (8), No. 2, 368-9 (Feb., 1959).

Describes some perspectives and possibilities of applying the method developed by the author (Abstr. 6054 of 1958) to diamagnetic molecules and non-metallic crystals. F.Lachman

539.2 : 538.2

1775 PARAMAGNETIC STUDY OF HYDROGENATED DILUTE PALLADIUM—IRON ALLOYS.
J.P.Burger, E.Vogt and J.Wucher.
C.R. Acad. Sci. (Paris), Vol. 249, No. 16, 1480-2 (Oct. 19, 1959).
In French.

Reports results on hydrogenated palladium alloys containing up to 7% Fe, and deduces that each Fe atom contributes 3 electrons to the Pd atoms. From the susceptibility measurements the moment per Fe atom is 5.9μ_B, (compare 5.91μ_B for Fe^{3+}); the paramagnetic Curie temperature was found to vary linearly with Fe content.
E.P.Wohlfarth

539.2 : 538.2

1776 MAGNETIZATION OF COMPOUNDS OF RARE EARTHS WITH PLATINUM METALS.
R.M.Bozorth, B.T.Matthias, H.Suhl, E.Corenzwit and D.D.Davis.
Phys. Rev., Vol. 115, No. 6, 1595-6 (Sept. 15, 1959).

Measurements were made of the Curie points and magnetic moments of three series of compounds (Laves phases) MIr_2, MOs_2, and MRu_2, where M is a rare-earth element. The Curie point is highest (85°K) for the compounds containing Gd and falls away when the rare earths have larger or smaller atomic numbers. This dependence of Curie point on the rare-earth element is in accord with the idea that the principal exchange interaction is between the spins of the 4f shell of the rare-earth ions and the conduction electrons. The magnetic moments are closely related to, but differ somewhat from, the values of Jg for the trivalent ions of M.

539.2 : 538.2

1777 MAGNETIC PROPERTIES OF THE MANGANESE CHROMITE-ALUMINATES. P.L.Edwards.
Phys. Rev., Vol. 116, No. 2, 294-300 (Oct. 15, 1959).

The mixed-crystal spinel series $MnCr_{2-t}Al_tO_4$ was synthesized and found to form a single cubic phase with a cell edge that is a linear function of the aluminium content. An X-ray study indicates that the series is an almost-normal spinel series with the A sites occupied by divalent manganese ions and about 5% of the trivalent aluminium ions. The magnetization—temperature curves have approximately zero slope at absolute zero and exhibit no peaks or compensation points. The saturation moment is 1.16 μ_B for $t = 0.0$, increasing to 1.37 μ_B at t = 0.8, and dropping to 1.25 μ_B at t = 1.0. The reciprocal-susceptibility versus temperature curves have the hyperbolic shape characteristic of ferrimagnets. The observed magnetic properties cannot be explained by the Néel theory but can be accounted for, at least qualitatively, by the five-parameter Yafet and Kittel theory (Abstr. 7388 of 1952).

539.2 : 538.2

1778

THE BEHAVIOUR OF THE PARAMAGNETIC IONS IN THE SINGLE CRYSTALS OF SOME SIMILARLY CONSTITUTED SALTS OF THE IRON GROUP OF ELEMENTS. II. HYDRATED Ni^{2+} SALTS.

A.Bose, S.C.Mitra and S.K.Datta.

Proc. Roy. Soc. A, Vol. 248, 153-68 (Nov. 11, 1958).

The magnetic anisotropy behaviour of seventeen similarly constituted hydrated Ni^{2+} salts was studied by the methods described in Pt I (Abstr. 6712 of 1957). In contrast with the similar Cu^{2+}, the Ni^{2+} salts have much smaller anisotropy and their temperature variation has a much larger departure from the Curie law as predicted by theory. It is also found that, in general, the two nearly equal ionic susceptibilities denoted by $K_\perp$ are greater than the third denoted by $K_\parallel$, unlike the Cu^{2+} salts. In Ni^{2+} salts the crystalline and the ionic magnetic axes change their directions with temperature, though much less than some of the Cu^{2+} salts. The coefficients in the theoretical equation for anisotropy are shown to be nearly as much structure and temperature sensitive as in the Cu^{2+} salts, in some cases. The anisotropic field coefficients related to the tetragonal orbital and spin splittings of the energy levels are calculated. The variation of these from salt to salt may be as large as 100% and with temperature 12%, in extreme cases. The general behaviour of the true alkali metal double salts is in marked contrast with, and appears to be intermediate between, those of the ammonium and thallium double salts and the two single salts. The spin–orbit coupling coefficient in crystals, calculated from the temperature variation of the anisotropy, comes reasonably close to the value $-324\ cm^{-1}$ for the free Ni^{2+} ion, whereas, from the room-temperature value of the anisotropy and paramagnetic resonance data it is found to be about 13% lower. This difference is ascribed to the inclusion of the "covalency factor" of about 0.87 in these Ni^{2+} salts, in the latter calculation.

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1779

CANTED SPIN ARRANGEMENTS.

P.G.de Gennes.

Phys. Rev. Letters, Vol. 3, No. 5, 209-11 (Sept. 1, 1959).

The properties of two spin systems in which canted spin systems are likely to occur — the ordered iron–aluminium alloy series and the tin-substituted yttrium iron garnet series — are discussed. S.A.Ahern

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1780

INTERATOMIC DISTANCES IN FERROMAGNETICS.

F.M.Gal'perin.

Zh. eksper. teor. Fiz., Vol. 34, No. 4, 1000-3 (April, 1958). In Russian. English translation in: Soviet Physics–JETP (New York), Vol. 34(7), No. 4, 690-2 (Oct., 1958).

An analogy is discussed between the dependence of the atomic magnetic moments of ferromagnetic metals and alloys on the electron concentration (s- and d-electrons), and the same dependence of a quantity having the dimensions of length, which for pure metals is equal to the difference between the distance of nearest neighbours of the first coordination sphere of the crystalline lattice and a certain constant of the metal. S.A.Ahern

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CRYSTAL SYMMETRY OF FERROMAGNETICS. See Abstr. 1695

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1781

THE INFLUENCE OF ORDERING ON THE MAGNETIC PROPERTIES OF A BINARY FERROMAGNETIC ALLOY.

Yan Shi.

Fiz. Metallov i Metallovedenie, Vol. 7, No. 2, 161-8 (1959). In Russian.

Anisotropy constants of binary ferromagnetic alloys are calculated as functions of temperature, field and degree of order. Good agreement is claimed with experimental results, in particular with the observed anomalous temperature dependence of the magnetic anisotropy of Ni–Fe ordering alloys. The temperature dependence of the spontaneous magnetization of alloys is also calculated. [English summary: PB 141126T-9, obtainable from Office of Technical Services, U.S. Dept. of Commerce, Washington, D.C., U.S.A.]. A.F.Brown

539.2 : 538.2

1782

THE BEHAVIOUR OF A FERROMAGNETIC IN A MAGNETIC FIELD CLOSE TO THE CURIE POINT.

V.M.Zaitsev.

Fiz. Metallov i Metallovedenie, Vol. 7, No. 2, 284-7 (1959). In Russian.

Starting from an expansion for the thermodynamic potential of a ferromagnetic in powers of the magnetization (M), formulae are derived for the susceptibility (χ), $(\partial \chi/\partial H)_T$, $(\partial M/\partial T)_H$ and for the specific heat and its variations with H and T. [English summary : PB 141126T-9, obtainable from Office of Technical Services, U.S. Dept. of Commerce, Washington, D.C., U.S.A.]. A.F.Brown

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1783

TEMPERATURE VARIATION OF THE PRINCIPAL MAGNETIC MOMENTS OF Co^{++} IONS AND THE ASYMMETRY OF THE CRYSTALLINE ELECTRIC FIELD IN COBALT ACETATE TETRAHYDRATE.

B.C.Guha.

Nature (London), Vol. 184, 50 (July 4, 1959).

Each Co^{++} ion in cobalt acetate tetrahydrate, $Co(CH_3COO)_2.4H_2O$, is surrounded by four water molecules and two oxygen atoms of the acetate groups. The cobalt–water and cobalt–acetate distances suggest that the magnetic moment of Co^{++} should be greater in the plane containing the Co^{++} ion and the oxygen atoms of the water molecules and the acetate groups than in a direction normal to this plane. Susceptibility measurements on a single crystal are reported in the temperature range from 80° to 300° K which support this view and which suggest the presence of a strong rhombic field around the Co^{++} ion. R.Parker

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1784

EXPLANATION FOR THE LOW-TEMPERATURE BEHAVIOR OF THE ANISOTROPY OF IRON.

W.J.Carr,Jr.

J. appl. Phys., Vol. 31, No. 1, 69 (Jan., 1960).

The seemingly anomalous results obtained by Graham for the temperature dependence of magnetic anisotropy in iron are interpreted on the basis of Zener's theory, with the effect of thermal expansion included.

539.2 : 538.2

1785

THEORETICAL APPROACH TO THE ASYMMETRICAL MAGNETIZATION CURVE.

A.Aharoni, E.H.Frei and S.Shtrikman.

J. appl. Phys., Vol. 30, No. 12, 1956-61 (Dec., 1959).

The method previously used to calculated the magnetization curve of an infinite cylinder is applied to the new Meiklejohn and Bean material which is made of Co particles in a CoO shell. It is assumed that the interface of the ferromagnetic and antiferromagnetic materials is held parallel to the cylindrical axis and does not change its direction for any value of the applied field. The crystal anisotropy is neglected. It is shown that the easiest nucleation mode for small radii is buckling and for large radii is curling. The transition from buckling to curling is at about $RI_SA^{-\frac{1}{2}} = 2$, where R is the radius of the cylinder, I_S is the saturation magnetization and A is the exchange constant. Numerical solution of the nonlinear equations involved, yields two branches in the magnetization curve, which are both stable with respect to curling perturbations. The general stability is not tested. A similar calculation is carried out for an infinite slab with the spins on the surface held at a fixed direction and with the crystal anisotropy neglected.

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1786

THE COERCIVE FORCE OF COLD-ROLLED NICKEL-, IRON- AND COBALT STRIPS.

A.Dupré and A.van Itterbeek.

Bull. Inst. Internat. Froid, Annexe 1958-1, 187-92.

Annealed strips of the three metals 100μ thick were prepared and strips progressively thinner by ~10μ prepared from these by cold rolling. The magnetoresistance of the strips was determined with the applied magnetic field successively in three mutually perpendicular directions. The maxima and minima on the resulting curves of $\Delta R/R$ versus field with this perpendicular and parallel to the measuring current enable the coercive force to be determined. The various results are shown in graphical form. The coercive force as a function of reduction in thickness is similar for iron and nickel, higher for the latter, and much higher for cobalt. For nickel the coercive force increases with decreasing temperature but the increase is much smaller than for evaporated layers.

F.E.Hoare

539.2 : 538.2

1787 SUSCEPTIBILITY [χ_p] OF THE PARA-PROCESS IN A Fe–Ni ALLOY [61.18 ATOMIC PERCENT Fe] IN THE TEMPERATURE RANGE 77-290°K. N.Z.Miryasov.
Fiz. Metallov i Metallovedenie, Vol. 6, No. 1, 188-90 (1958).
In Russian.

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1788 MAGNETIZATION OF THE COMPOUND TiFe. M.V.Nevitt.
J. appl. Phys., Vol. 31, No. 1, 155-7 (Jan, 1960).

Magnetization curves were determined for the CsCl-type compound TiFe at six temperatures ranging from 9° to 110°K. The curves show a saturation effect at high field strength but they are of a form that is not characteristic ferromagnetism. A saturation magnetization of 3.30 ± 0.07 c.g.s. units per gram was derived from the high field data. This moment is tentatively interpreted as resulting from a small concentration of uncompensated spins produced by disorder in the CsCl-type lattice. The electrical resistance of TiFe samples was measured over the temperature range from 10°K to room temperature. Magnetization measurements were attempted on the CsCl-type compounds TiCo and TiNi, but their magnetizations were too small to be detected.

539.2 : 538.2

1789 THE SPONTANEOUS MAGNETIZATION OF NICKEL + COPPER ALLOYS.
S.A.Ahern, M.J.C.Martin and W.Sucksmith.
Proc. Roy. Soc.A, Vol.248, 145-52 (Nov. 11, 1958).

The spontaneous magnetization ($\sigma_{0,T}$) of a ferromagnetic may be deduced exclusively from the determination of magnetic isothermals, or in conjunction with magnetocaloric measurements. Values of $\sigma_{0,T}$ of a nickel + copper alloy containing 30.75 at. % of copper have been obtained near its Curie temperature using both of these techniques and are shown to be in good agreement. Measurements of spontaneous magnetization and Curie temperature (θ_f) of nickel + copper alloys containing up to 54.11 at. % of copper using the purely magnetic techniques are described. These measurements were performed over a temperature range from θ_f down to 80°K in all cases, and to 23°K in the cases of alloys containing over 30 at.% of copper. The magnetic moments per atom (p_B) of the alloys, which are deduced from the measurements, vary linearly over a wide range of composition, extrapolating to $p_B = 0$ at 53 at. % of copper. This value is in good agreement with that obtained by Meyer and Wolff (1958), and contrary to that based on the familiar measurements of Alder (1916). The reduced magnetization–temperature curves of some of the alloys are given and these show a continuous marked decrease in fullness with increasing copper content.

539.2 : 538.2

1790 ISOLATION OF ROTATIONAL REVERSAL IN FERROMAGNETIC FILMS. A.L.Hanzel and R.L.Conger.
J. appl. Phys., Vol. 30, No. 12, 1932-6 (Dec., 1959).

Quantitative data are presented which show the relative contributions of wall motion and domain rotation to the magnetization reversal process in thin ferromagnetic films for driving fields ranging from the coercivity to many times the anisotropy field. Also, an equation for the total magnetization reversal time is developed. This expression consists of two distinct components: one represents wall motion reversal time and the other reversal time due to domain rotation.

539.2 : 538.2

1791 CHEMICAL REMANENT MAGNETIZATION OF FERROMAGNETIC MINERALS AND ITS APPLICATIONS TO ROCK MAGNETISM. K.Kobayashi.
J. Geomagn. Geoelect., Vol. 10, No. 3, 99-117 (1959).

Experimental studies have been carried out on the remanent magnetization generated by chemical reactions (which may properly be called chemical remanent magnetization or C.R.M. in abbreviation) for both natural and synthetic specimens. Remanent magnetization generated during two kinds of reaction processes, reduction of α-Fe_2O_3 to Fe_3O_4 and oxidation of Fe_3O_4 to maghemite is firstly examined (Part I). It may be safely concluded that the remanent magnetization thus generated has an intensity which is intermediate between isothermal remanent magnetization and thermo-remanent magnetization, and that its magnetic and thermal stability is similar to that of thermo-remanent magnetization, much higher than that of isothermal remanent magnetization. In Part II, magnetic properties of several natural rocks and ore deposits containing maghemite are systematically examined. The results suggest that various magnitudes of remanence can be generated by chemical processes according to the mode of precipitation of ferromagnetic minerals.

539.2 : 538.2

1792 PARTICLE INTERACTION IN MAGNETIC RECORDING TAPES. J.G.Woodward and E.DellaTorre.
J. appl. Phys., Vol. 31, No. 1, 56-62 (Jan., 1960).

The magnetic coating of recording tape is assumed to be composed of an assemblage of small, single-domain particles. Each particle is assumed to have a symmetrical, square hysteresis loop when the reversible component of magnetization is neglected and when the particle is not influenced by the fields of neighbouring particles. When influenced by the fields of its neighbours, the particles may exhibit an asymmetrical loop when the loop is plotted relative to an external applied field. In this case the positive and negative switching fields for the particle are not equal, and their difference gives an indication of the particle interaction. While it is not possible to measure the switching fields of a single particle on the recording tape, the distribution of switching fields in the assemblage of particles and the associated magnetic moment can be measured. The two switching fields and the magnetic moment define a 3-dimensional distribution function which describes the magnetic properties of the tape, and in terms of which both d.c. and anhysteretic magnetization processes may be described. The distribution functions have been measured for two recording tapes. While the functions for the two tapes are markedly different in detail, both show that particle interaction is very appreciable in recording tapes and that it is a significant factor in determining the bulk magnetic properties and the recording performance of tapes.

539.2 : 538.2 : 621.318.2

1793 THERMOMAGNETIC GENERATOR. J.F.Elliott.
J. appl. Phys., Vol. 30, No. 11, 1774-7 (Nov., 1959).

Calculations are made for the power output and the efficiency of energy conversion of a thermomagnetic generator. Particular attention is paid to the use of the ferromagnetic element gadolinium as a suggested material for a practical device for the generation of electrical power from a low grade heat source (i.e. in the neighbourhood of 20°C).

539.2 : 538.2

1794 MAGNETIC SURFACE EFFECT IN THE MAGNETIZATION OF FLAT BODIES IN A CURVED FIELD.
Yu.D.Sȳchev.
Fiz. Metallov i Metallovedenie, Vol. 4, No. 2, 378-80 (1957).
In Russian.

539.2 : 538.2

1795 THE PRACTICAL MAGNETIZATION OF FERROMAGNETICS.
L.V.Kirenskii, M.K.Savchenko and I.F.Degtyarev.
Dokl. Akad. Nauk. SSSR, Vol. 128, No. 2, 288-90 (1959).
In Russian.

The change in domain structure of ferromagnetic materials is observed by means of powder figures and the magneto-optical effect of Kerr. It is found that in addition to the combination of boundaries between domains and the rotation process, an important role is played by a process of reorganisation of the domain structure to what corresponds to the maximum permeability and the biggest number of Barkhausen jumps.

K.N.R.Taylor

539.2 : 538.2

1796 MEASUREMENT OF THE BREADTH OF THE BOUNDARY LAYER BETWEEN DOMAINS IN FERROMAGNETICS.
L.V.Kirenskii and V.V.Veter.
Dokl. Akad. Nauk SSSR, Vol. 125, No. 3, 526-9 (March 21, 1959).
In Russian.

Experiments were made on specimens of 3% silicon-iron. Details are given of the preparation of a specimen and of a Kerr magneto-optical system to measure the amount of light reflected from a "clear" piece of the crystal and from a small part crossed by the boundary layer. From these two measurements the breadth of the boundary layer may be calculated. From their experimental results it is concluded that the boundary width is not a stable quantity; in one specimen it was 0.89 μ, in a second 0.64 μ. In the majority of cases the domains are somewhat wedge-shaped.

C.R.S.Manders

539.2 : 538.2 : 548.74

1797 NEUTRON STUDY OF THE CRYSTAL AND MAGNETIC STRUCTURES OF $MnFe_{2-t}Cr_tO_4$.

S.J.Pickart and R.Nathans.

Phys. Rev., Vol. 116, No. 2, 317-22 (Oct. 15, 1959).

Powder neutron diffraction measurements were performed at temperatures down to 4.2°K on three compositions in the mixed spinel series $MnFe_{2-t}Cr_tO_4$ ($0 \leq t \leq 2$). Separation of the nuclear and magnetic scattering was accomplished both by applying an external field and by measuring the neutron intensities above the Curie temperature. Analysis of the nuclear scattering indicates that all the compounds investigated have essentially the normal spinel structure, the fraction of divalent atoms on the tetrahedral sites being about 0.8, 0.9, and 1.0 for $t = 0.5$, 1.0, and 1.5, respectively, while in every case the Cr atoms are located on the octahedral sites. The magnetic scattering is consistent with antiparallel A- and B-site moments, with no evidence being found for ordered triangular configurations. The magnitude of the A-site moments in each instance is approximately the moment value of the cations located there, while the B-site moments are significantly lower than expected on this basis. These results can be attributed to the occurrence within the B sublattice of spin-quenched cations, random antiparallel spins, or short-range ordered trangular configurations, since any of these alternatives lowers the sublattice moment on the average.

539.2 : 538.2 : 548.73

1798 MAGNETIC AND X-RAY INVESTIGATIONS ON THIN IRON LAYERS. G.Becherer, O.Brümmer and H.Poser.

Exper. Tech. der Phys., Vol. 7, No. 1, 33-9 (1959). In German.

The magnetic properties of layers of various thicknesses were studied by means of the Faraday effect, results being in good agreement with König's conclusions (Zeitschrift für Metallkunde, Vol. 43, 26, 1952). The reduction in lattice constant with decreasing thickness was also determined by X-ray methods.

L.Pincherle

539.2 : 538.2

1799 MEASUREMENT OF THE MAGNETIZATION OF THIN FILM. S.Yamaguchi.

J. Colloid Sci., Vol. 14, No. 4, 452-4 (Aug., 1959).

The magnetic induction of a nickel film 5μ thick and of an iron film approximately 1μ thick was measured from the diffraction pattern of a transmitted electron beam. R.Parker

539.2 : 538.2

1800 MEASUREMENT OF THE LINEAR MAGNETOSTRICTION OF HARD-WORKED NICKEL. H.E.Stauss.

J. appl. Phys., Vol. 30, No. 11, 1648-50 (Nov., 1959).

The influence of plastic deformation upon the linear magnetostriction has been determined by use of direct measurements of strain in three normal directions and then by measurement of magnetostriction in the same three directions using the method of rotating the specimen 90° for each measurement. This combination of measurements appears to have advantages for the interpretation of magnetostriction in anisotropic bodies. The value of magnetostriction at saturation for grade A nickel plastically deformed with an 34% reduction of cross-sectional area was found to be $-33.5 \pm 1 \times 10^{-6}$. This compares with $-35 \pm 1 \times 10^{-6}$ for annealed nickel of the same quality. The hard-worked nickel was free of volume magnetostriction of determinable magnitude. It showed inappreciable preferred domain orientation. It did appear to have a small amount of preferred crystalline orientation.

539.2 : 538.2

1801 MAGNETOSTRICTION OF HEXAGONAL SYSTEM FERROMAGNETICS. Yu.B.Kostyanitsyn.

Fiz. Metallov i Metallovedenie, Vol. 4, No. 2, 375-6 (1957). In Russian.

539.2 : 538.2

1802 A NEW METHOD FOR DETERMINING SINGLE-CRYSTAL MAGNETOSTRICTION CONSTANTS.

C.P.D'yakov.

Fiz. Metallov i Metallovedenie, Vol. 6, No. 1, 168-70 (1958). In Russian.

539.2 : 538.2

1803 MAGNETIC VISCOSITY IN IRON DUE TO CARBON ATOMS ANCHORED IN DISLOCATIONS.

G.Biorci, A.Ferro, and G.Montalenti.

J. appl. Phys., Vol. 30, No. 11, 1732-5 (Nov., 1959).

A specimen of iron containing 0.01% of C in solid solution has been cold worked by 7% and aged at room temperature. After this treatment it shows a new peak of magnetic viscosity at 180°C. The diffusion process giving rise to the peak is controlled by an activation energy of about 32 000 cal/g atom and a time constant at infinite temperature of about 10^{-14} sec. These figures agree with those of a peak of internal friction observed in similar specimens by Kê (1948) and by Köster (1954), and interpreted as due to diffusion of C atoms in the surroundings of the dislocations. Hence the peak of magnetic viscosity can be related to the same mechanism.

539.2 : 538.2

1804 X-RAY STUDY OF FERROMAGNETIC DOMAINS IN COBALT ZINC FERRITE. K.M.Merz.

J. appl. Phys., Vol. 31, No. 1, 147-54 (Jan., 1960).

Double crystal diffractometer and X-ray micrograph techniques were used to study ferromagnetic domains in cobalt zinc ferrite single crystals. Diffraction curves of the (400) reflection were observed to broaden when a magnetic field was applied to the crystal. Berg–Barrett X-ray micrographs showed there was a "d" spacing shift in the crystal during the magnetization process.

539.2 : 538.2

1805 RECTANGULAR HYSTERESIS LOOP FERRITES WITH LARGE BARKHAUSEN STEPS.

A.P.Greifer and W.J.Croft.

J. appl. Phys., Vol. 31, No. 1, 85-8 (Jan., 1960).

Observations have been made at low temperatures of large discontinuities (steps) in the 60-cycle hysteresis loops of polycrystalline ferrites containing copper. At the temperature for step formation, which is a function of copper content, the coercivity decreases and the loop squareness approaches unity. This behaviour is attributed to the formation (in the toroidal specimens used) of circular 180° domain walls having different threshold fields. This domain wall configuration is probably brought on at low temperatures by a low effective magnetocrystalline anisotropy provided by the localized distortions exerted by divalent copper in the spinel lattice.

539.2 : 538.2

1806 FARADAY EFFECT OF VARIOUS FERRITE RODS. F.Picherit.

C.R. Acad. Sci. (Paris), Vol. 249, No. 1, 69-70 (July 6, 1959). In French.

The variation of the Faraday rotation with field strength is given for rods of various dimensions. For unsaturated ferrite rods the rotation is not proportional to the length because of the demagnetizing field. This field is constant if rods of equal length are placed end to end, and the rotation is then proportional to the total length. When the diameter of the rod exceeds about 0.2 of that of the waveguide and the length of the rod is suitably chosen, as the field is increased the rotation passes through a maximum, becomes negative and passes through a minimum; with longer rods the rotation is negative at all field strengths. The absorption and ellipticity show maxima at the field corresponding to the point of inflexion of the curve of the rotation. R.C.Kell

539.2 : 538.2

1807 ON THE TRANSITION TEMPERATURE OF COPPER FERRITE. H.Ohnishi, T.Teranishi and S.Miyahara.

J. Phys. Soc. Japan, Vol. 14, No. 1, 106 (Jan., 1959).

The tetragonal deformation of slowly cooled copper ferrite-chromite decreases with increasing chromium content and therefore with an increase in the proportion of cupric ions in tetrahedral sites of the spinel lattice. If this proportion exceeds 0.25, either as a result of the chromium content or of quenching pure copper ferrite from above 760°C, the structure is cubic. The variation of the tetragonality with temperature is given for copper ferrite and for two copper ferrite-chromites. R.C.Kell

539.2 : 538.2

1808 THE MAGNETOCRYSTALLINE ANISOTROPY OF COBALT-SUBSTITUTED MANGANESE FERRITE.

R.F.Pearson.

Proc. Phys. Soc., Vol. 74, Pt 5, 505-12 (Nov., 1959).

The first order anisotropy constant K_1 was measured by torque methods on substituted manganese ferrite crystals containing 1, 2, 4, 6, 8, 10 and 25 mol% cobalt ferrite from 160° to 200°K. The contribution to the anisotropy from the cobalt ions is found to vary linearly with cobalt concentration up to 25%. The extrapolated contributions of the cobalt ions in manganese ferrite lead to K_1 values of 0.8×10^6 ergs cm^{-3} compared with the value of 3×10^6 found for cobalt ferrite and $K_1 = 1.5 \times 10^7$ for cobalt substitution in magnetite. The anisotropy contribution is found to vary much faster with temperature for substitution in manganese ferrite than in magnetite.

539.2 : 538.2

1809 DETERMINATION OF MOLECULAR FIELD COEFFICIENTS IN FERRIMAGNETS.

G.T.Rado and V.J.Folen.

J. appl. Phys., Vol. 31, No. 1, 62-8 (Jan., 1960).

An improved method is presented for determining those three molecular field coefficients which yield essentially the best agreement between the Néel theory and the experimental curve of saturation moment per unit mass (σ) versus temperature (T) in a given ferrimagnetic material. This method is analytical, and for a given accuracy it is more rapid than previously used trial-and-error methods. Experimental data on σ versus T are presented for monocrystals of lithium ferrite and two compositions of magnesium-iron ferrite. One of the latter ferrites was measured in two states of ionic distribution which were obtained by varying the heat treatment. Application of the analytical method to these data shows that the agreement between the Néel theory and experiment is somewhat better than that expected on the basis of previous work. The present method is particularly useful for determining the temperature dependence of the sublattice magnetizations. Accurate values of these magnetizations are required, for example, in calculation of the temperature dependence of magnetocrystalline anisotropy by means of crystalline field theory.

539.2 : 538.2

1810 NEW MECHANISM OF ANTIFERROMAGNETISM.

A.W.Overhauser.

Phys. Rev. Letters, Vol. 3, No. 9, 414-16 (Nov. 1, 1959).

Suggests a mechanism to account for the anomalous properties of dilute Cu—Mn alloys. It is shown that a static spin density wave is a solution of the Hartree—Fock equations for the conduction electrons and that the interaction energy with solute spins makes such a state energetically favourable below a critical temperature T_C ; T_C is proportional to the solute concentration c in agreement with experiment. The low-temperature magnetic specific heat is given by $C_M = \gamma_M T$ where γ_M is independent of c. This agrees with Zimmerman's recent experimental results (to be published).

D.M.Edwards

539.2 : 538.2

1811 ANTIFERROMAGNETIC MAGNON DISPERSION LAW AND BLOCH WALL ENERGIES IN FERROMAGNETS AND ANTIFERROMAGNETS. R.Orbach.

Phys. Rev., Vol. 115, No. 5, 1181-4 (Sept. 1, 1959).

The exact eigenstates of the exchange Hamiltonian $\mathcal{H}=2J\,\Sigma_l\, S_l.S_{l+1}-\frac{1}{4})$, are found for short chains of 4, 6, 8, and 10 atoms of spin $\frac{1}{2}$. A linear dispersion law for magnons in an antiferromagnet is exhibited by the energy spectrum. The periodic boundary conditions ($S_{N+l}=S_l$ where N is the number of spins in the chain) are then removed and the spins at the two ends of the chain are constrained to be either parallel or antiparallel to each other. The eigenstates for these arrangements are computed and give the exact energy of the 180° Bloch wall. This energy is compared with the semiclassical result. It is found that the semiclassical ferromagnetic Bloch wall energy is in good agreement with the exact wall energy. The energy of the semiclassical antiferromagnetic Bloch wall is not in good agreement with the exact wall energy but appears to have the correct dependence on the wall thickness.

539.2 : 538.2

1812 SPIN—ELECTRON RELAXATION IN AN ANTIFERROMAGNETIC. Yu.Seidov and A.Berdyshev.

Fiz. Metallov i Metallovedenie, Vol. 7, No. 2, 298-9 (1959). In Russian.

Tsukernik (Abstr. 4121 of 1958) investigated the thermal equilibrium of a system of spin-waves on the basis of their interactions with each other and with phonons. This paper considers the interaction of spin-waves with conduction electrons. The calculated mean spin—electron relaxation frequency $W \cong 10^8/T\ sec^{-1}$.

[English summary: PB 141126T-9, obtainable from Office of Technical Services, U.S. Dept. of Commerce, Washington, D.C., U.S.A.].

A.F.Brown

539.2 : 538.2

1813 CLASSICAL SPIN-CONFIGURATION STABILITY IN THE PRESENCE OF COMPETING EXCHANGE FORCES.

T.A.Kaplan.

Phys. Rev., Vol. 116, No. 4, 888-9 (Nov. 15, 1959).

It is pointed out that Yafet—Kittel triangular arrangements (Abstr. 7388 of 1952) are not stable in the cubic spinel. The stability criterion used is that the classical Heisenberg energy should not decrease for small, but otherwise arbitrary, spin-deviations from the configuration of interest. It is found that the Yafet—Kittel—Prince configuration can probably be stabilized by a sufficient tetragonal distortion of the pattern of B—B interactions. In addition, the classical ground state is found for the antiferromagnetic body-centered cubic lattice with first, second, and third neighbour antiferromagnetic interactions (with parameters J_1, $J_1\sigma_2$ and $J_1\sigma_3$): the spin $S(R_n)$ at lattice point R_n is independent of time, is always parallel to one plane P, and the angle made by $S(R_n)$ with a fixed line in P is of the form $k \cdot R_n$ for R_n a cube corner, and of the form $k \cdot R_n + \pi$ for R_n a body-centre position with the vector k determined by the σ_i. The neutron diffraction pattern for such a "spiral" configuration (with $\sigma_2 \sim 0.6$, $\sigma_3 \sim 0.1$, for example) bears a close relationship with the unusual pattern obtained by Corliss, Hastings, and Weiss with a single crystal of chromium.

539.2 : 538.2

1814 SUGGESTION CONCERNING MAGNETIC INTERACTIONS IN SPINELS. D.G.Wickham and J.B.Goodenough.

Phys. Rev., Vol. 115, No. 5, 1156-8 (Sept. 1, 1959).

The indirect-exchange mechanisms which produce spontaneous magnetization in metal oxides are an optimum if two interacting cations are located on opposite sides of an anion. The coupling rules which have been developed for this case are not applicable to spinels in which the cation—anion—cation angles differ appreciably from 180°. An examination of the d-orbital symmetry of various cations in respect to the crystal lattice leads to several suggestions concerning the magnetic interactions in spinels. Of particular interest are those spinels containing cations with three or fewer d electrons in the octahedral sites, or four if the symmetry is tetragonel. The properties of several spinels of this kind are considered in the light of the suggestions offered. Direct interactions between octahedral-site cations appear to be possible.

539.2 : 538.2

1815 ANISOTROPY IN MAGNETIC SUSCEPTIBILITY AND DEPENDENCE OF HEAT CAPACITY ON FIELD DIRECTION IN AN ANTIFERROMAGNET. E.A.Turov.

Zh. eksper. teor. Fiz., Vol. 34, No. 4, 1009-11 (April, 1958). In Russian. English translation in: Soviet Physics - JETP (New York) Vol. 34 (7), No. 4, 696-7 (Oct., 1958). English Summary: PB 141052T-3 obtainable from Office of Technical Services, U.S. Dept. of Commerce, Washington, D.C., U.S.A.

Results are given of calculations of the temperature dependence of susceptibility and of magnetic specific heat of a uniaxial antiferromagnetic crystal. The results are based on the spin—wave theory and are given for applied magnetic fields both larger and smaller than the magneto-crystalline field.

R.Parker

539.2 : 538.2

1816 ANTIPHASE ANTIFERROMAGNETIC STRUCTURE OF CHROMIUM.

L.M.Corliss, J.M.Hastings and R.J.Weiss.

Phys. Rev. Letters, Vol. 3, No. 5, 211-12 (Sept. 1, 1959).

Characteristic splittings were observed in the magnetic superstructure reflections during a neutron diffraction study of chromium single crystals grown by the strain-anneal method. These have been attributed to an antiphase domain structure — by analogy with antiphase domains in ordered alloys. The Bohr magneton value obtained from the integrated intensities of the magnetic superstructure peaks (100), (111) and (210) is 0.4 ± 0.05 in agreement with Shull and Wilkinson (Abstr. 8525 of 1953). The magnetic form factor is in agree agreement with that of Mn^{2+}, the Néel temperature is 35 ± 2°C, coinciding with anomalies in other physical properties, but not with powder neutron diffraction data.

S.A.Ahern

539.2 : 538.2

1817 THEORY OF SUPEREXCHANGE.

F.Keffer and T.Oguchi.

Phys. Rev., Vol. 115, No. 6, 1428-34 (Sept. 15, 1959).

The Dirac—Van Vleck—Serber spin-operator expansion, first applied by Anderson to the Kramers superexchange problem, is extended, simplified, and systematized in order to handle all overlap contributions arising from a number of interacting configurations. The linear cation–anion–cation (e.g., Mn^{++}-O^{--}-Mn^{++}) four-electron problem is worked out in detail, taking account of all contributions from configurations (a) ionic, (b) electron transferred to right, (c) electron transferred to left. Group symmetry requirements are invoked; and these, together with a simple approximation equivalent to perturbation theory, are shown to reduce the complicated matrix formulation to a single linear equation. The solution contains terms previously obtained by Anderson, by Anderson and Hasegawa, and by Yamashita, and a number of important extra terms. All superexchange terms are fourth order or higher in the overlap S. A rough numerical evaluation with modified Slater wave-functions appropriate to MnO-type crystals yields an effective superexchange integral of the required size. Brief consideration is given to configurations in which two electrons are transferred, in particular (d) simultaneous transfer of electrons to right and to left (Slater mechanism). Unless the energy required to form this configuration is surprisingly small, its contribution is probably not so important, although the problem needs to be investigated in detail. Some consideration is also given to the linear cation–anion–anion–cation (e.g., Mn^{++}-Br^{-}-Br^{-}-Mn^{++}) problem; the formal solution for the ionic configuration is worked out; and it is shown that superexchange terms first appear in the order S^4T^2, where S is the anion—cation overlap and T is the anion—anion overlap.

539.2 : 538.2

1818 MAGNETIC STRUCTURE OF THE ALLOY MnAu$_2$.

A.Herpin, P.Mériel and J.Villain.

C.R. Acad. Sci. (Paris), Vol. 249, No. 15, 1334-6 (Oct. 12, 1959). In French.

A neutron diffraction study of MnAu$_2$ shows that the manganese atoms are contained in equally spaced parallel planes, perpendicular to the c-axis, with their magnetic moments parallel. The direction of the magnetic moments in successive planes are at 102° to each other. It is shown that this antiferromagnetic structure can be predicted theoretically. S.A.Ahern

Magnetic Resonances

539.2 : 538.27

1819 NOTE ON THE SATURATION OF THE MAIN RESONANCE IN FERROMAGNETICS. H.Suhl.

J. appl. Phys., Vol. 30, No. 12, 1961-4 (Dec., 1959).

The course of χ'' at resonance versus applied power is traced for various ratios of intrinsic to scattering line widths. It is assumed that the line width contribution from thermal spin—wave agitation is negligible.

539.2 : 538.27

1820 THEORY OF FERROMAGNETIC RESONANCE IN RARE EARTH GARNETS. I. g VALUES. C.Kittel.

Phys. Rev., Vol. 115, No. 6, 1587-90 (Sept. 15, 1959).

Ferromagnetic resonance phenomena in rare earth iron garnets (except Gd iron garnet) are dominated at room temperature and above by the rapid spin relaxation of the rare earth ions. The rare earth ion relaxation controls the g values and the line widths, as well as the temperature dependence of these quantities. It is shown that in the appropriate limit the g value of the microwave spin resonance line satisfies the relation $g = g_A(M_A + M_B)/M_A$, where g_A and M_A refer to the ferric lattice and $M_A + M_B$ is the net saturation magnetization of the crystal. This relation obtains essentially when the B lattice relaxation frequency is high in comparison with the AB exchange frequency and relaxation frequency of the A lattice. The theory accounts quite well, with no disposable parameters, for the sequence and temperature variation of the g values reported for Dy, Ho, Er, Yb, and Sm iron garnets. When at low temperatures the B relaxation frequency becomes sufficiently low, the g value should approach the usual result for two coupled undamped lattices, in the absence of anisotropy effects on the B lattice. The theory predicts further that at ordinary temperatures the exchange frequency resonance will occur at the usual position and its width will be proportional to the damping constant of the B lattice.

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1821 THEORY OF FERROMAGNETIC RESONANCE IN RARE EARTH GARNETS. II. LINE WIDTHS.

P.G. De Gennes, C.Kittel and A.M. Portis.

Phys. Rev.,Vol. 116, No.2, 323-30 (Oct. 15, 1959).

The spins of rare-earth ions in the garnets are coupled strongly both to the lattice phonons and, by an exchange interaction, to the ferric spin lattice. The rare-earth spins thus provide a powerful relaxation channel for the ferric lattice. Two contributions to the line width may be distinguished: a coherent process (in which the total magnetic moment of the ferrite lattice relaxes without changing the magnitude of the moment) is dominant at temperatures from 0°K up to just below the Curie temperature. Near and above T_c a fluctuation process (in which ferric spins flip locally) is dominant. The theoretical results describe the order of magnitude and the temperature dependence of the observed line widths in the rare earth garnets and in impure yttrium iron garnet, if one assumes in the absence of direct experimental knowledge that the relaxation frequency $1/\tau$ of the relevant rare earth ions is $\sim 10^{-12}$ sec at 400°K. As the temperature is increased from 0°K, the width increases until a maximum is reached when $1/\tau$ becomes comparable with the ferric-rare earth exchange frequency. Above this temperature the width decreases until near T_c, where there is a sharp rise. (See also Abstr. 9797 of 1959).

539.2 : 538.27

1822 SPIN WAVE SPECTRA FOR CANTED ANTIFERROMAGNETS AND FERROMAGNETS. R.Orbach.

Phys. Rev., Vol. 115, No. 5, 1189-93 (Sept. 1, 1959).

The magnetic resonance conditions and the spin wave spectra are found for canted antiferromagnetic and ferromagnetic lattices, where the cant is produced by magnetocrystalline anisotropy fields which are noncollinear. The sublattices are thereby caused to cant towards each other in antiferromagnets and away from each other in ferromagnets. The cant of the antiferromagnetic sublattices may produce a net moment (weak ferromagnetism) but does not alter appreciably the usual antiferromagnetic spin wave spectrum in the presence of anisotropy. The static susceptibility parallel ($\chi_{\parallel}$) and at right angles ($\chi_{\perp}$) to the vector difference of the anisotropy fields is calculated, and is shown to be altered from the noncanted result. It is shown that in antiferromagnets with no apparent weak ferromagnetism, canted sublattices may still be present, and can be detected by a nonzero ratio of $\chi_{\parallel}$ to $\chi_{\perp}$ at 0°K. The ferromagnetic spin wave spectrum shows a sudden change from the normal spectrum as soon as one introduces the noncollinear anisotropy fields. An optical branch is formed and a high-frequency $k = 0$ magnetic resonance is expected. This resonance is a consequence of the two-sublattice character of the canted ferromagnet and may be termed an exchange resonance.

539.2 : 538.27

1823 SPATIAL DIFFUSION OF SPIN ENERGY.

A.G.Redfield.

Phys. Rev., Vol. 116, No. 2, 315-16 (Oct. 15, 1959).

A procedure is outlined for evaluating the spatial diffusion coefficient of magnetization of spins on a rigid lattice. The temporal recession of a spatially sinusoidally varying magnetization is analysed, and is reduced to the problem of finding a function whose moments are known. An unambiguous value of diffusion coefficient can be obtained but the possibility of a complete lack of diffusion cannot be ruled out.

539.2 : 538.27

1824 SIGN OF THE GROUND-STATE CUBIC CRYSTAL FIELD SPLITTING PARAMETER IN Fe^{3+}. S.Geschwind.

Phys. Rev. Letters, Vol. 3, No. 5, 207-9 (Sept. 1, 1959).

The splitting mechanism of the nominally spherically symmetrical $6S_{5/2}$ ground state of Fe^{3+} in cubic crystal fields was investigated. It has been shown previously [Progr. theor. Phys., Vol. 18, 405 (1957)] that the sign of a in the cubic term of the ground-state spin-Hamiltonian $a(S_\xi^4 + S_\eta^4 + S_\zeta^4)$ should be independent of the sign of V, the cubic crystal potential. This was verified experimentally for Fe^{3+} in yttrium gallium garnet, a being positive in both the octahedrally and tetrahedrally co-ordinated sites. The room temperature parameters measured at 24 kMc/s for both sites are:-

	Octahedral	Tetrahedral
D	–1384 ± 3 Oe	–947 ± 5 Oe
a	198 ± 5 Oe	66 ± 3 Oe
F	28 ± 4 Oe	– 42 ± 4 Oe
g	2.003 ± 0.001	2.0047 ± 0.0005

The spectrum of Fe^{3+} in rubidium aluminium sulphate (Abstr. 4728 of 1954) was re-examined, and a found to be positive in this material also. S.A.Ahern

539.2 : 538.27

1825 SECOND RELAXATION IN A SPIN SYSTEM IN CERTAIN COMPOUNDS OF ELEMENTS OF THE IRON GROUP.

N.S.Garif'yanov.

Zh. eksper. teor. Fiz., Vol.35, No.2(8), 530-2 (Aug., 1958). In Russian. English translation in Soviet Physics—JETP (New York), Vol.35(8), No.2, 366-7 (Feb., 1959).

A study of magnetic absorption in hydrated salts of Mn^{++}, Fe^{++} Cu^{++} for polarizing field parallel or perpendicular to the r.f. field for various frequencies and for the temperature range 90 to 300°K. A maximum in χ'' as a function of $H_{\parallel}$ is interpreted in terms of "second relaxation" (see Abstr. 2542 of 1953). J.G.Powles

539.2 : 538.27

1826 PARAMAGNETIC RESONANCE OF F CENTERS IN POTASSIUM IODIDE. G.A.Noble.

J. chem. Phys., Vol. 31, No. 4, 931-8 (Oct., 1959).

Measurements were made at 293°, 77° and 4°K. Additively-coloured crystals of several concentrations and X-rayed crystals showed the same resonance with g=1.970 and a width of 213 G at maximum slope. The saturation of the absorption was measured. The resonances of F-centres in potassium halides are compared.

539.2 : 538.27

1827 SATURATION OF THE PARAMAGNETIC RESONANCE OF A V CENTER. T.G.Castner, Jr.

Phys. Rev., Vol. 115, No. 6, 1506-15 (Sept. 15, 1959).

The saturation of the paramagnetic resonance of the $(\text{halogen})_2^-$ complex (V_K centre) in the alkali halides was studied. The saturation of the absorption signal ($\chi''H_1$) versus H_1 is obtained over a 60dB power range for KCl, KBr, and LiF at 78°K. Portis' theory of inhomogeneous saturation has been generalized by omitting the assumption that the individual spin packet width is very much smaller than the envelope width. Methods are developed to determine independently from a given experimental saturation curve the spin-packet width $1/T_2$, the spin-lattice relaxation time T_1, and the product T_1T_2. For KCl and LiF values of T_2, T_1 and T_1T_2 are determined for the different hyperfine lines of the V_K centre spectrum. For KBr only the product T_1T_2 could be obtained. From the results it is concluded that the spin-packet width is not limited by T_1. For KCl at 78°K, $T_1 \sim 7T_2$; for LiF, T_2 is two orders of magnitude or more less than T_1 and depends in a complicated manner on the external magnetic field and the angle between the V_K centre axis and the external field.

539.2 : 538.27

1828 SPIN-LEVEL INVERSION AND SPIN-TEMPERATURE MIXING IN RUBY. R.H.Hoskins.

Phys. Rev. Letters, Vol. 3, No. 4, 174-5 (Aug. 15, 1959).

An experiment is described in which successive inversion of spin levels in Cr^{3+} in ruby, by adiabatic fast passage, are performed in such a way that the excess population of spins is pumped to a higher level at each inversion (christened a "staircase" inversion). The experiment was performed at 1.4°K using a pulsed magnetic field, and various pulses of maser oscillation were observed after the staircase inversion when the field passed the appropriate value. J.M.Baker

539.2 : 538.27

1829 OPTICAL PUMPING IN CRYSTALS.

H.H.Theissing, P.J.Caplan, F.A.Dieter, and N.Rabbiner.

Phys. Rev. Letters, Vol. 3, No. 10, 460-2 (Nov. 15, 1959).

The possibility of optical pumping of such systems as Eu^{2+} in CaF_2 or $SrCl_2$ thus changing the magnetic resonance absorption is discussed and compared with that involving the red absorption line of ruby. Further comparison with the case of F-centres in KCl shows the latter to be a most favourable choice for pumping experiments at low temperatures. G.F.J.Garlick

539.2 : 538.27

1830 DIPOLAR LINE BROADENING AND ENHANCED PSEUDO-DIPOLAR MOMENTS. R.L.White.

Phys. Rev., Vol. 115, No. 6, 1519-20 (Sept. 15, 1959).

The assumption of a strongly enhanced pseudo-dipolar moment in certain ferrimagnetic and antiferromagnetic materials is shown to be incompatible with the paramagnetic resonance line-widths in these materials. Why the concept of pseudo-dipolar moments is not applicable to line-width calculations is discussed.

539.2 : 538.27

1831 SPIN–SPIN PARAMAGNETIC RELAXATION TIME IN THE ABSENCE OF A STATIC MAGNETIC FIELD FOR $Co(NH_4)_2(SO_4)_2.6H_2O$ AT HELIUM TEMPERATURES.

U.Kh.Kopvillem.

Zh. eksper. teor. Fiz., Vol. 35, No. 2 (8), 506-7 (Aug., 1958). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 35 (8), No. 2, 349-50 (Feb., 1959).

Numerical values of the electron spin—spin relaxation time are calculated for this magnetically anisotropic crystal containing two non-equivalent types of ion, for different directions of an oscillatory magnetic field with respect to the crystal axes. E.F.W.Seymour

539.2 : 538.27

1832 ELECTRON-SPIN RESONANCE OF NITROGEN DONORS IN DIAMOND.

W.V.Smith, P.P.Sorokin, I.L.Gelles and G.J.Lasher.

Phys. Rev., Vol. 115, No. 6, 1546-52 (Sept. 15, 1959).

Electron-spin resonance of bound substitutional nitrogen donors in diamond was observed and is discussed. The g factor is isotropic at 2.0024 ± 0.0005. For a given donor, one of the C—N bond directions is a hyperfine axis with constants A = 40.8 Oe, B = 29.2 Oe. There are thus four types of donors, equally abundant. A model for the donor wave-function is proposed which puts the donor electron principally into an antibonding orbital located on a nitrogen atom and on one of its nearest-neighbour carbon atoms. A C—N bond distortion results which can be regarded as a manifestation of the Jahn—Teller effect. A careful search reveals the presence of an additional weak spectrum due to donors on N^{14}—C^{13} pairs. (The isotope C^{13} which has a nuclear spin of $\frac{1}{2}$ has a natural abundance of 1.1%). The hyperfine constants measured for a C^{13} atom of an N—C pair are A' = 60.8 Oe, B' = 25.3 Oe. The s and p contributions to all 4 measured hyperfine constants are separated to give the values

$$O_N = (8\pi/3)\left|\psi(0)\right|^2{}_N = 2.41 \text{ atomic units},$$

$$P_C = \langle[z^2-\tfrac{1}{2}(x^2+y^2)]/r^5\rangle_C = 0.28 \text{ atomic units},$$

$$O_N = (8\pi/3)\left|\psi(0)\right|^2{}_N = 0.78 \text{ atomic units},$$

$$P_C = \langle z^2-\tfrac{1}{2}(x^2+y^1)/r^5\rangle_C = 0.25 \text{ atomic units}.$$

These are compared with theoretical values obtained by assuming a simple antibonding wave-function composed of nitrogen and carbon tetrahedral orbitals. An increase of several percent in the N—C separation along the hyperfine axis is strongly implied by the comparison.

539.2 : 538.27

1833 OPTICAL DETECTION OF PARAMAGNETIC RESONANCE SATURATION IN RUBY. I.Wieder.

Phys. Rev. Letters, Vol. 13, No. 10, 468-70 (Nov. 15, 1959).

Ruby consisting of Cr^{3+} ions in a host crystal of Al_2O_3 has sharp lines in its optical absorption and emission spectra. Fluorescent radiation of these sharp lines from one ruby, after polarization, was used as a source for measuring the absorption of a second ruby in a microwave cavity. Microwave saturation of the $\frac{1}{2}$ to $-\frac{1}{2}$ transition in the ground state of the Cr^{3+} ions in the second ruby was observed to change the optical absorption by about 1%. Attempts to disturb the equilibrium population of the sublevels of the ground state by optical pumping and to detect this disturbance by e.s.r. were unsuccessful, but marginal signal/noise was expected. J.M.Baker

539.2 : 538.27

1834 ELECTRON PARAMAGNETIC RESONANCE OF THE V^{+++} ION IN SAPPHIRE.

G.M.Zverev and A.M.Prokhorov.

Zh. eksper. teor. Fiz., Vol. 34, No. 4, 1023-4 (April, 1958). In Russian. English translation in: Soviet Physics—JETP (New York), Vol. 34(7), No. 4, 707-8 (Oct., 1958).

One line of the spectrum has been observed at 4.2°K at frequencies between 14 and 38 kMc/s and it is split into eight equi-spaced components by hyperfine interaction. The line was obtained with the magnetic field parallel to the z-axis of the crystal. Using the spin Hamiltonian of Abragam and Pryce, values for the constants

g_{11} and A were deduced which agreed with values obtained from susceptibility measurements on vanadium ammonium alums.
D.J.Oliver

539.2 : 538.27

1835

THE PRINCIPAL g VALUES OF YTTERBIUM IONS IN YTTRIUM ACETATE A TRICLINIC CRYSTAL.

J.G.Park.
Proc. Phys. Soc., Vol. 74, Pt 5, 513-16 (Nov., 1959).

The principal g values of ytterbium ions in yttrium acetate have been determined by a method which requires that the single crystal specimen can be rotated about a horizontal axis inside the cavity of a paramagnetic resonance apparatus, as well as the more usual requirement that the horizontal magnetic field can be rotated about a vertical axis. By this method the principal g values are measured directly when they are located, whereas in other methods that have been proposed they are calculated from measurements of certain g values and angles. The orientation of the g tensor was not determined in our experiments, but a method for finding it is outlined here. The results were (choosing x, y, z so that $g_x > g_y > g_z$) $g_x = 4.583 \pm 0.008$, $g_y = 2.117 \pm 0.004$, $g_z = 0.71 \pm 0.03$.

539.2 : 538.27

1836

OVERHAUSER EFFECT IN METALLIC LITHIUM.

M.Gueron and C.Ryter.
Phys. Rev. Letters, Vol. 3, No. 7, 338-40 (Oct. 1, 1959).

The sample consisted of LiH heavily irradiated with pile neutrons. At 300°K the nuclear resonance signal was increased up to a factor of 100 by saturating the spin resonance. The value deduced for the ratio of the nuclear spin lattice relaxation time T_1, to the relaxation time caused by electron–nuclear coupling T_1e is smaller than a previous value [Abstr. 7227 of 1955] probably due to the incomplete penetration of the r.f. field. At 4.2°K a distribution of electron spin resonance shifts was observed owing to the variation in the size of the metallic grains. The results on line shape were in general agreement with theory.
D.J.Oliver

539.2 : 538.27

1837

THEORY OF THE NUCLEAR MAGNETIC RESONANCE SHIFT IN PARAMAGNETIC CRYSTALS.

F.Keffer, T.Oguchi, W.O'Sullivan and J.Yamashita.
Phys. Rev., Vol. 115, No. 6, 1553-61 (Sept. 15, 1959).

A theoretical study is made of the shift of the F^{19} nuclear resonance in paramagnetic and antiferromagnetic MnF_2 which has been observed by Shulman and Jaccarino (Abstr. 7322 of 1958). The problem is reduced to that of a single Mn–F pair. A net hyperfine interaction is shown to arise from overlap effects in the ground-state ionic configuration $(3d)^5(2s)^2(2p)^6$ and from overlap and transfer effects to the configurations $(3d)^6(2s)(2d)^6$ and $(3d)^6(2s)^2(2p)^5$. These three configurations are equivalent to a single configuration involving bonding-type molecular orbitals. The results are in reasonable agreement with the experiment, the theoretical isotropic shift being slightly too small and the theoretical anisotropic shift (small non-dipolar part) being slightly too large. A re-appraisal is made of Tinkham's data on paramagnetic resonance of Mn^{++} impurities in ZnF_2, which Bleaney has shown to be closely related to Shulman–Jaccarino data. It is found that there is no need to include, as did Tinkham, a large fraction of fluorine 3s and 3p functions into the bond.

539.2 : 538.27

1838

POLARIZATION OF THE Al^{27} NUCLEI IN RUBY.

J.A.Cowen, W.R.Schafer and R.D.Spence.
Phys. Rev. Letters, Vol. 3, No. 1, 13-14 (July 1, 1959).

Dynamic polarization, of the type discussed by Abragam and Proctor (Abstr. 7316 of 1958) was observed in ruby. A change in the amplitude of the nuclear magnetic resonance signal of the aluminium nuclei was produced when the specimen, containing 0.1% chromium, was irradiated at 4.2° K with microwave power at 9300 Mc/s and the external magnetic field adjusted to be close to a paramagnetic resonance line of the chromium.
J.M.Baker

539.2 : 538.27

1839

APPLICATION OF NUCLEAR QUADRUPOLE RESONANCE IN DETERMINATION OF THE FREQUENCY OF LATTICE VIBRATIONS IN A SERIES OF CHLORATES.

V.C.Grechishkin and F.I.Skripov.
Dokl. Akad. Nauk. SSSR, Vol. 126, No. 6, 1229-31 (June 21, 1959).
In Russian.

The temperature variation of nuclear quadrupole resonance in chlorates of monovalent and divalent metals has been examined. Observations of the Raman scattering spectrum indicate both high- and low–frequency components of the lattice vibration in chlorates, the former corresponding to the internal motion of the chlorate group. The average frequency of rotational oscillation, and the temperature coefficient of the nuclear quadrupole resonance frequency in both types of chlorate were determined. The temperature coefficient in monovalent materials was found to be twice that in divalent materials. The lifetime of the quanta of rotational oscillation was determined for calcium chlorate.
K.N.R.Taylor

MECHANICAL PROPERTIES OF SOLIDS

539.3

1840

ELASTIC CONSTANTS OF SINGLE CRYSTAL BERYLLIUM.

J.F.Smith and C.L.Arbogast.
J. appl. Phys., Vol. 31, No. 1, 99-102 (Jan., 1960).

The five independent elastic constants of beryllium have been determined with the pulse echo technique at a frequency of 10 Mc/s. The values extrapolated to 0° K are $C_{11} = 29.94 \pm 0.06$, $C_{33} = 34.22 \pm 0.12$, $C_{44} = 16.62 \pm 0.05$, $C_{12} = 2.76 \pm 0.08$, $C_{13} = 1.1 \pm 0.5$ in units of 10^{11} dyne/cm^2. Voigt averaging and Reuss averaging of the single crystal elastic constants give excellent agreement because of the small magnitude of the nondiagonal elements, C_{12} and C_{13}. The averaged values compare favourably with previous data from polycrystalline beryllium.

539.3

1841

DETERMINATION OF ELASTIC MODULI OF SINTERED METAL POWDER COMPACTS USING AN ULTRASONIC METHOD.

P.Rama Rao and A.A.Krishnan.
J. sci. industr. Res., Vol. 18B, No. 6, 260-1 (June, 1959).

The elastic moduli of sintered and cast specimens of Al, Bi, brass, Cu and Sn were deduced from measurements of the different resonance frequencies of thin circular compacts, the thickness vibrations of which were excited by a wedge-shaped quartz crystal. The results showed that, when the density of the sintered and cast materials was about the same, there was little difference between their elastic moduli but when the sintered material had a lower density than the cast, the corresponding moduli were much lower.
H.J.H.Starks

539.3

1842

A METHOD OF MEASURING THE COMPLEX DYNAMIC ELASTIC MODULUS.

H.Andres.
Hochfrequenztech. u. ElektAkust., Vol. 67, No. 6, 174-80 (March, 1959). In German.

A description is given of a system for measuring the elasticity and loss factor of materials over a wide range of frequencies (20 to 300 c/s). The apparatus consisted of a vibrating table on which the specimen was placed. Force and velocity were measured mechanically, and corresponding electrical measurements were made by means of a suitable bridge system indicating impedance magnitudes and phase relationships. A number of experimental curves are given in illustration, showing the elasticity modulus and loss factor as a function of frequency. The materials tested were various types of foam rubber and pure rubber. In the latter case, a number of resonance frequencies were observed.
A.B.Wood

539.3

1843

TEMPERATURE DEPENDENCE OF FRACTIONAL VELOCITY CHANGES IN A GERMANIUM SINGLE CRYSTAL.

F.Stein, N.G.Einspruch and R.Truell.
J.appl. Phys., Vol.30, No.11, 1756-8 (Nov., 1959).

An ultrasonic interferometer technique for measuring the temperature dependence of relative changes in elastic constants has been utilized to study the variation of c_{11} for germanium. Results are reported for measurements carried out as a function of frequency from 30 to 170 Mc/s for compressional wave propagation along the [100] direction in two sets of compatible germanium samples over the temperature range from $-60°$ to 0° C. The mean value of $(1/c_{11})(dc_{11}/dT)$ is $78.87 \times 10^{-6} (°C)^{-1}$, and no systematic frequency dependence of $(1/c_{11})(dc_{11}/dT)$ was found.

539.32

1844 ELASTIC CONSTANTS OF GERMANIUM UNDER HYDROSTATIC PRESSURES UP TO 12 000 kg/cm^2.
J.Koppelmann and G.Landwehr.
Z. angew. Phys., Vol. 11, No. 5, 164-7 (May, 1959). In German.

Ultrasonic measurements were made of the transverse wave velocity in Ge single crystals under hydrostatic pressures up to 12 000 kg/cm^2. The adiabatic elastic constants and isothermal compressibility at 20°C are given. There is a linear relationship between the constants and the pressure. H.J.H.Starks

539.32

1845 THE EFFECT OF DEFORMATION ON THE INTERNAL FRICTION OF IRON MEASURED AT THE CARBON PEAK POSITION. F.W.C.Boswell.
Canad. J. Phys., Vol. 37, No. 12, 1474-81 (Dec., 1959).

Experiments have been carried out to investigate the influence of deformation on the internal friction of iron measured at the carbon peak. As a result of deformation the internal friction increased and then decreased with time. These changes, corrected for a background change associated with the deformation, were shown to follow a time law predicted for carbon segregation to dislocations. It is concluded that the amount of carbon in random solid solution is increased by the deformation. By analyzing the rate of decrease of internal friction following deformation in terms of strain-aging theory the final dislocation densities were determined. The results also indicate that in some cases the carbon put into solution by the deformation was initially present in the form of iron carbide particles.

539.32

1846 ON THE MECHANICAL LOSS OF POLYETHYLENE. Y.Wada.
J. Phys. Soc. Japan, Vol. 13, No. 11, 1408-9 (Nov., 1958).

The available data for branched and unbranched polyethylene are plotted as frequency of maximum loss against inverse temperature for the three observed loss peaks. Activation energies are found to be 40, 30 and 9 kcal/mole. R.F.S.Hearmon

539.37

1847 NEW INTERNAL FRICTION PEAKS AT LOW TEMPERATURES.
V.A.Pavlov, N.F.Kryuchkov and I.D.Fedotov.
Fiz. Metallov i Metallovedenie, Vol. 5, No. 2, 371-2 (1957).
In Russian.

Pure Al and an Al–Mg alloy (3% Mg) were studied. Two internal friction peaks were observed in the following temperature ranges: room temperature to liquid nitrogen; -50° to -90°C; -170° to -180°C.

539.37

1848 INFLUENCE OF PLASTIC DEFORMATION ON INTERNAL FRICTION AND ON SHEAR MODULUS OF SILVER CHLORIDE. Yu.Kh.Vekilov and M.P.Shaskol'skaya.
Dokl. Akad. Nauk SSSR, Vol. 128, No. 1, 71-2 (Sept. 1, 1959).
In Russian.

The temperature dependence is investigated of internal friction and of shear modulus of monocrystals and of polycrystals of AgCl, caused by plastic deformation and by annealing. The results are illustrated. J.K.Skwirzynski

539.3

MECHANICAL DAMPING OF VIBRATING PLATE CRYSTALS OF CdS. See Abstr. 1715

539.37

1849 THE EFFECT OF HEAT TREATMENT AND PLASTIC DEFORMATION ON INTERNAL FRICTION IN METALS.
Yu.K.Favstov.
Fiz. tverdogo Tela, Vol. 1, No. 3, 499-508 (March, 1959). In Russian.

Experiments carried out on Al and 2 types of steel (0.11 and 0.56% C) showed that both the logarithmic decrement δ_0, determined from the rate of decaying of vibrations at amplitudes varying from a maximum to zero, and a coefficient K, describing the amplitude dependence of δ_0, were affected by thermal treatment (annealing, hardening, tempering, ageing) and plastic deformation. In the case of steels, the value of K, lowest after hardening, was increased tenfold by annealing, the effect of thermal treatment on δ_0 being much smaller and different for each steel. Both δ_0 and K were decreased by plastic deformation and ageing. M.H.Sloboda

539.37

1850 THE DEFORMATION OF SODIUM AND POTASSIUM AT LOW TEMPERATURES: TENSILE AND ELECTRICAL RESISTIVITY EXPERIMENTS. D.Hull and H.M.Rosenberg.
Bull. Inst. Internat. Froid, Annexe 1958-1, 193-8.

Extruded specimens of Na and K were tested over a temperature range from 4.2° to 195°K. Yield stress, ultimate tensile stress and elongation are tabulated. The stress–strain curves for Na and K differ greatly probably due to a low temperature martensite transformation in Na which is absent in K. An increase in electrical resistivity in Na proportional to strain was observed at 4.2°K, but not at 20°K. No reliable results were obtained with K.
J.E.Caffyn

539.37

1851 THE DEFORMATION OF FACE-CENTRED CUBIC METALS AT LOW TEMPERATURES. Z.S.Basinski.
Bull. Inst. Internat. Froid, Annexe 1958-1, 203-9.

The change of flow stress with both temperature and strain rate was measured in such a way that reversible and irreversible effects could be separated. Single crystals of Cu, Ag, Al and polycrystalline Al were tested over a range from 1.7° to 473°K. The mechanism of hardening by effective interaction with forest dislocations only is used to interpret the results. J.E.Caffyn

539.37

1852 THERMODYNAMIC INVESTIGATIONS OF RELATIONS BETWEEN STRESSES AND DEFORMATIONS IN ISOTROPIC ELASTO-PLASTIC MEDIA. A.A.Vakulenko.
Dokl. Akad. Nauk SSSR, Vol. 126, No. 4, 736-9 (June 1,1959).
In Russian.

The rheological equations are derived in terms of free energy and entropy density functions as well as the dissipation function. The latter depends on the absolute temperature and on the components of the plastic deformation velocity tensor; in particular, for an isotropic medium, the dissipation function is given explicitly in terms of the invariants of the velocity tensor. J.K.Skwirzynski

539.37

1853 THE CHARACTER OF DEFORMATION IN THE REGION OF PLASTICITY. I.M.Gryaznov.
Dokl. Akad. Nauk SSSR, Vol. 126, No. 6, 1250-3 (July 21, 1959).
In Russian.

A descriptive account of the appearance of slip bands and grain rotations during deformation of polycrystalline metals.
I.D.C.Gurney

539.37

1854 ISOTROPIC HARDENING OF PLASTIC BODIES. D.D.Ivlev.
Dokl. Akad. Nauk SSSR, Vol. 127, No. 4, 777-9 (Aug. 1, 1959).
In Russian.

A theoretical paper in which an expression is obtained for the flow hardening of an ideally plastic body subject to the Tresca flow condition. The application to extension, torsion, plane stress, plane strain, axially symmetric and three dimensional systems is briefly discussed. R.F.S.Hearmon

539.37

1855 INITIAL STAGE OF THE PLASTIC DEFORMATION OF METALS. B.A.Sidorov.
Fiz. Metallov i Metallovedenie, Vol. 6, No. 1, 191-2 (1958).
In Russian.

539.37

1856 PLASTICITY OF SOME ALLOYS UNDER HIGH (HYDROSTATIC) PRESSURES.
Yu.N.Ryabinin, L.D.Livshits and L.F.Vereshchagin.
Fiz. tverdogo Tela, Vol. 1, No. 3, 476-81 (March, 1959). In Russian.

The effect of hydrostatic pressure P (up to 29 000 atm) on plasticity (true strain S_f) of duralumin, a heat-resisting steel (Cr 17.34%, Ni 26.5%, Ti 0.015%, C 0.35%), iron and steel 45 (C 0.46%, Mn 0.71%, Si 0.28%) stressed in tension, was studied. A linear $S_f = f(P)$ relationship was obtained for all these alloys except steel 45; in this case, the rate of increase of S_f with P decreased suddenly at P ≅ 12 000 kg/cm^2. Metallographic examination of the "neck" of the iron specimen extended under pressure showed that all grains had been elongated in the direction of the applied load.
M.H.Sloboda

539.37

1857 THE QUESTION OF THE ORIGIN OF INCREASED PLASTICITY UNDER THE INFLUENCE OF HIGH HYDROSTATIC PRESSURE. Yu.N.Ryabinin.
Fiz. tverdogo Tela, Vol. 1, No. 6, 960-2 (June, 1959). In Russian.

It is shown diagrammatically that the resolved shear stress under a combination of tensile and hydrostatic stress increases with increase of the hydrostatic component, thus explaining the increase of plasticity in tension specimens with increase in hydrostatic pressure. R.F.S.Hearmon

539.37

1858 PLASTIC DEFORMATION OF InSb BY UNIAXIAL COMPRESSION.
J.J.Duga, R.K.Willardson and A.C.Beer.
J. appl. Phys., Vol. 30, No. 11, 1798-1803 (Nov., 1959).

Plastic deformation by uniaxial compression was found to produce decreases in both the electron mobility and magnetoresistance, but to have no effect on the Hall coefficient. Analyses of the temperature dependence of the conductivity mobility and the weak-field magnetoresistance, in terms of mixed scattering by acoustic lattice vibrations and ionized impurities, suggest that the principal effect of this mode of deformation is the creation of ionized vacancies and interstitials in approximately equal densities. The analysis permits an estimate of the density of point defects, which can then be related to the total energy expended during deformation. Reference is made to the effects of plastic bending of InSb where the carrier concentration is affected. This behaviour is similar to results on silicon and germanium which have been analysed in terms of the Shockley—Read trapping model.

539.3 : 534.22

A SHOCK WAVE IN A PLASTIC MEDIUM. See Abstr. 993

539.37

1859 TRANSMISSION ELECTRON MICROSCOPY STUDIES OF THE MECHANISM OF PLASTIC DEFORMATION.
A.Berghezan and A.Fourdeux.
J. appl. Phys., Vol. 30, No. 12, 1913-22 (Dec., 1959).

Observation of the deformation of thin aluminum specimens inside the transmission electron microscope has revealed the intimate connection between deformation and the nucleation and motion of dislocations. Nucleation, slip propagation, and the progress of deformation to the point of rupture have been observed visually on the fluorescent screen and photographed by both "still" and motion picture techniques. In this way even the detailed predictions of the dislocation theory of deformation have been confirmed, and the new phenomena of grain boundaries acting as "donors" or "acceptors" of dislocations have been discovered.

539.37

1860 GRAIN BOUNDARY MIGRATION AND DIMENSIONAL CHANGE OF LOW CARBON STEEL.
M.Okada and T.Watanabe.
J. Phys. Soc. Japan, Vol. 14, No. 1, 107-8 (Jan., 1959).

The authors investigated the effects of low-temperature annealing on cold-worked specimens of low-carbon steel (0.2% carbon). Above 100° C a slight increase of the extension or compression was observed, although the volume remained constant. These changes are due to grain boundary migration so as to release high stress concentrations caused by dislocation pile-ups. The volume contraction observed below 100° C is attributed to the disappearance of excess point defects. M.G.Priestley

539.4

1861 MECHANICAL PROPERTIES OF UNIT TWINNED LAYERS. R.I.Garber.
Fiz. tverdogo Tela, Vol. 1, No. 5, 814-825 (May, 1959). In Russian.

A description of experiments on elastic twinning and twinned layers, with loads applied either in step form or according to a definite programme of loading. The work shows the influence of hysteresis and relaxation, and the phenomena of flow, creep and hardening are observed. Two different types of hardening are shown to exist: mechanical, due to crushing at the boundaries of the twinned layers, and diffusional, influenced by the concentration of vacancies and similar distortion of the layers. P.G.Morgan

539.4

1862 MECHANICAL PROPERTIES OF RHOMBIC POLYCRYSTALLINE SULPHUR. I. M.Wobst.
Wiss. Z. Hochsch. Maschinenbau Karl-Marx-Stadt, Vol. 1, No. 1, 40-4 (1958/59). In German.

The following properties were investigated: 1. Notched-bar impact strength as a function of the temperature, 2. tensile strength in air, water, and carbon disulphide, at room temperature, 3. Brinell, Vickers, and micro-hardness, at room temperature. The results of the experiments are communicated and discussed, but no theoretical conclusions are drawn: CS_2 does not affect the tensile strength of the undissolved sulphur. The fracture was perpendicular to the direction of the force. J.Smuts

539.4

1863 NOTE ON THE SCRATCHING OF DIAMOND.
R.H.Wentorf, Jr.
J.appl. Phys., Vol.30, No.11, 1765-8 (Nov., 1959).

The resistance of diamond to wear is a strong function of its orientation. The observed facts can be explained by assuming that a scratched diamond surface fails in tension behind the scratching particle. The octahedral cleavage planes are most easily pulled apart and give rise to the strong dependence of wear on crystal orientation.

539.4

1864 AN APPROXIMATE ANALYSIS OF STRESSED CONDITIONS IN RUBBER SAMPLES TESTED FOR TEARING BY DIFFERENT METHODS. A.I.Lukomskaya.
Dokl. Akad. Nauk SSSR, Vol. 127, No. 6, 1207-9 (Aug. 21, 1959). In Russian.

Three types of sample are considered, with different curvatures of upper surfaces at the points of tearing. The method of analysis follows closely that used by Kutilin in his book. All samples indicate a simple relation between tearing stresses and degrees of deformation. J.K.Skwirzynski

539.4

1865 THE RELATIONSHIP BETWEEN RUPTURE AND TEARING OF RUBBER.
M.M.Reznikovskii and A.I.Lukomskaya.
Dokl. Akad. Nauk SSSR, Vol. 128, No. 1, 75-7 (Sept. 1, 1959). In Russian.

The authors describe an approximate extrapolation method of measuring qualitatively true stresses in the vicinity of tears in rubber. The results are tabulated and these suggest a modification of Greensmith's and Thomas' relationship between the specific energies of rupture and of tearing. The statistical coefficient of variance of breaking stress is also tabulated for various types of rubber. J.K.Skwirzynski

539.4

1866 TEMPERATURE DEPENDENCE OF THE MECHANICAL PROPERTIES AND TIME-TO-RUPTURE CHARACTERISTICS OF METALLOCERAMIC BODIES.
B.Ya.Pines and A.F.Sirenko.
Fiz. tverdogo Tela, Vol.1, No.2, 275-83 (Feb., 1959). In Russian.

The temperature dependence of the U.T.S. was experimentally determined for sintered Cu, Ni, Mo, W, Cu—Ni, Cu—Fe, Ni—Fe, and Ni—W specimens, and the results were used to determine constants in an equation describing the relationship between time-to-rupture, load, and temperature. The validity of this equation, based on the theory of diffusion growth of cracks, was confirmed by life-to-rupture tests. The activation energy of the process leading to fracture, calculated from this equation, corresponded to the activation energy of self-diffusion. Since the experimental specimens, whose elongation decreased with rising temperature, failed by what can be described as brittle fracture, the laws formulated in the present paper are not applicable to materials that fail in a ductile manner.
M.H.Sloboda

539.4

1867 INVESTIGATION OF THE MECHANICAL PROPERTIES OF SOLID BODIES, ESPECIALLY METALS, AT TEMPERATURES OF 4.2°K ABSOLUTE AND BELOW. II. TESTING OF MACROCRYSTALLINE ALUMINIUM (99.996%) AND ULTRA-STRONG ALUMINIUM ALLOY V-95 IN RUPTURE.
O.V.Klyavin and A.V.Stepanov.
Fiz. tverdogo Tela, Vol. 1, No. 6, 955-9 (June, 1959). In Russian.

Stress—strain curves in tension at 1.6, 4.2, 78 and 300°K are reproduced for annealed 99.996% Al, and the type of fracture is shown in each case. The results are discussed in relation to the occurrence of defects and of plastic deformation in the specimens.
R.F.S.Hearmon

539.4

1868 COMPOSITE BEAMS (CORES) USED AS MEANS OF INCREASING CARRYING ABILITY AND OF AVOIDING BRITTLENESS AT POINTS OF LOAD CONCENTRATION.
G.V.Uzhik.
Dokl. Akad. Nauk SSSR, Vol. 126, No. 1, 41-3 (May 1, 1959).
In Russian.

Steel beams, supported at ends were submitted to central, concentrated loads; identical notches were cut under the points of application of loads and the bending is shown as a function of load, for various areas of load application and for several beam thicknesses. The brittleness appears at critical values of these parameters. It is shown that composite beams show better performance under identical loading conditions. J.K.Skwirzynski

539.4

1869 STABLE CRACKS DEVELOPED IN BRITTLE SUBSTANCES UNDER DESTRUCTIVE LOADING.
G.I.Barenblatt.
Dokl. Akad. Nauk SSSR, Vol. 127, No. 1, 47-50 (July 1, 1959).
In Russian.

Stable cracks do not change their dimensions under variable loading. The author shows that the size of such crack depends only on the initial loading and on a new universal constant K, called by him the "modulus of cohesion", which is characteristic for a given substance. This modulus is then related to the parameters of Griffith's theory of the crack formation: $K^2 = \pi ET/(1 - \nu^2)$, where E = Young's modulus, ν = Poisson's ratio and T = surface tension. J.K.Skwirzynski

539.4

1870 A NEW RELATION FOR THE FATIGUE FRACTURE OF METALS. V.S.Ivanova.
Dokl. Akad. Nauk SSSR, Vol. 127, No. 1, 86-9 (July 1, 1959).
In Russian.

The author analyses the dislocation movements which make up the plastic deformation which causes fracture, and derives a relation between N_W (the number of cycles which produces fracture at a stress corresponding to the elastic limit) and N_1^W (the number of cycles needed to produce submicroscopic cracks at the same stress). This relation is then tested against the experimental values for various iron alloys and good agreement is obtained. M.G.Priestley

539.4

1871 ADSORPTIVE LOWERING OF STRENGTH AND BRITTLE RUPTURE OF ZINC AND CADMIUM SINGLE CRYSTALS. Yu.V.Goryunov, N.V.Pertsov and P.A.Rebinder.
Dokl. Akad. Nauk SSSR, Vol. 127, No. 4, 784-7 (Aug. 1, 1959).
In Russian.

Zinc and cadmium single crystals of various orientations were coated with gallium and tested in tension. Graphs are given of the limiting crystallographic shear, and of the normal and shear stresses at rupture, as functions of orientation. The lowering of crystallographic shear and ultimate strength at all orientations is also shown for gallium-coated cadmium. The results for zinc are compared with previous results for mercury-coated zinc. A possible explanation for the reduction of strength, based on the formation of microcracks, is suggested. R.F.S.Hearmon

539.56

1872 EFFECT OF ATMOSPHERE CONDITIONS ON THE BRITTLENESS OF NaCl. E.S.Machlin and G.T.Murray.
J. appl. Phys., Vol. 30, No. 11, 1731-2 (Nov., 1959).

Contrary to the results of previous investigators, it has been found that molecular O_2 and N_2 have no effect on the ductility of rock salt single crystals. Also, it has been found that air-aged crystals are brittle in summer and are ductile during a major fraction of the time in winter. Ductile rock salt crystals have been made brittle by subjecting them to ozone, NO, and atomic oxygen atmospheres. It is believed the ozone content of the atmosphere is responsible for the reported effects on brittleness. Other embrittling agents have been found.

539.61

1873 THE ADHERENCE OF FLUORESCENT FILMS ON GLASS SURFACES. II. THE EFFECT OF ALKALI SALTS ON THE ADHERENCE OF FLUORESCENT FILMS.
I.Hangos.
Exper. Tech. der. Phys., Vol. 7, No. 2, 71-7 (1959). In German.

For Pt 1 see Abstr. 8945 of 1959. An investigation of the effect of the properties of the sedimentation liquid on adherence of films when water glass is used as the binding medium, various alkali salts being used as coagulators. The effects of the various anions and cations are stated but no relation between adherence and pH of the sedimentation solution could be found. T.C.Toye

539.61

1874 FORCES BETWEEN TITANIUM DIOXIDE PIGMENT PARTICLES. - J.E.Latty and W.C.Clark.
Nature (London), Vol. 184, 49-50 (July 4, 1959).

The aggregation properties of dry rutile particles were studied with the electron microscope. The force of adhesion between two particles, determined from the maximum particle length supported at one contact, was calculated as $\geq 6 \times 10^{-7}$ dynes. This is interpreted as an induced electrostatic force rather than a Van der Waals force. B.T.M.Willis

539.8

1875 BEHAVIOR OF POLYTETRAFLUOROETHYLENE (TEFLON) UNDER HIGH PRESSURES.
R.I.Beecroft and C.A.Swenson.
J. appl. Phys., Vol. 30, No. 11, 1793-8 (Nov., 1959).

The presence of polymorphic phase transitions, apparently unique among high polymers, enhances interest in polytetrafluoroethylene, while its potentialities for cryogenic applications make low temperature data particularly valuable. Compression measurements have been made on samples of Teflon at various temperatures between 75° and 380° K and at pressures up to 21 000 atm. The phase diagram found for the region above the ice point is in qualitative agreement with previously published results, with a possible additional transition appearing above room temperature at pressures of over 11 000 atm. Time effects and a large pressure hysteresis make the transition parameters quite ambiguous, and the hysteresis becomes so broad at low temperatures that the phase diagram cannot be extended below the ice point. An apparent negative thermal expansion indicated by the isothermal compression measurements is shown to result from an incomplete high pressure transition. From an engineering standpoint, the measurements indicate that a Teflon gasket loaded to 3000 atm at room temperature should maintain a seal at any lower temperature.

CRYSTALLOGRAPHY

CRYSTAL STRUCTURES

539.2 : 548

1876 ON THE CRYSTAL STRUCTURE OF PROTACTINIUM METAL. J.Donohue.
Acta cryst., Vol. 12, Pt 9, 697-8 (Sept., 1959).

It is suggested that Zachariasen's data (Abstr. 4018 of 1952) are practically as consistent with an orthorhombic structure for protactinium metal as they are with the tetragonal structure proposed by Zachariasen. (See also following abstract). R.F.S.Hearmon

539.2 : 548

1877 ON THE CRYSTAL STRUCTURE OF PROTACTINIUM METAL. W.H.Zachariasen.
Acta cryst., Vol. 12, Pt 9, 698-700 (Sept., 1959).

The original films have been re-examined, and it is concluded that the orthorhombic structure proposed by Donohue (previous abstract) must be rejected because it does not fit the data. R.F.S.Hearmon

539.2 : 548

1878 OPTICAL OBSERVATION OF THE TRANSFORMATION OF CRISTOBALITE CRYSTALS AND STATISTICAL EVALUATION. O.Krisement and G.Trömel.
Z. Naturforsch., Vol. 14a, No. 7, 685-6 (July, 1959). In German.

Using a hot-stage microscope and polarised light the $\alpha \rightleftharpoons \beta$ transformation temperatures of 200 single crystals were measured. The following results were obtained: (a) Each crystal possessed two transformation temperatures, T_1 for $\alpha \rightarrow \beta$ and T_2 for $\beta \rightarrow \alpha$. The smallest value of $(T_1 - T_2)$ was several °C. (b) The transformation of each crystal (mean diameter 5μ) took place in less than 0.1 sec.

(c) T_1 and T_2 were separately distributed on Gaussian curves.
(d) There was no correlation between T_1 and T_2, i.e. in a batch of crystals with given T_1, T_2 was independent of T_1.

B.T.M.Willis

539.2 : 548.5

1879 PREPARATION AND SOME PROPERTIES OF YTTRIUM HEXABORIDE.

G.A.Kudintseva, M.D.Polyakova, G.V.Samsonov and B.M.Tsarev.
Fiz. Metallov i Metallovedenie, Vol. 6, No. 2, 272-5 (1958).
In Russian.

Yttrium hexaboride was produced from Y_2O_3 and B_4C by a vacuum thermal process. The lattice parameters, density, microhardness, melting point, thermoelectric e.m.f. against Cu, and electronic emission constants were determined. The results are discussed in relation to the basic electronic structure of the material.

R.F.S.Hearmon

539.2 : 548.5

1880 SOME PROPERTIES OF ZINC SULFIDE CRYSTALS GROWN FROM THE MELT. A.Addamiano and M.Aven.

J. appl. Phys., Vol. 31, No. 1, 36-9 (Jan., 1960).

Hexagonal zinc sulphide crystals were obtained by controlled cooling of melted zinc sulphide. Both pure and activated zinc sulphide powders were used. The density of pure melt grown crystals was found to be higher than that of natural zinc blende crystals or crystals grown by evaporation. The stability of the pure hexagonal crystals towards transformation to the cubic zinc-blende structure in the interval of temperature 700-1150° C was investigated. A full conversion to the cubic phase was never observed. The experimental evidence indicates the transition point to be above 1150° C.

539.2 : 548.5

1881 THE FUNCTION OF CONSTITUTIONAL SUPERCOOLING IN CRYSTAL GROWTH. W.A.Tiller.

Canad. J. Phys., Vol. 37, No. 10, 1204 (Oct., 1959).

It is shown that Kirkaldy's conclusion (Abstr. 8987 of 1959) that constitutional supercooling is eliminated at the cell caps as a consequence of the minimum entropy production condition is incorrect. The cells adopt that morphology compatible with thermal and constitutional constraints which produces the minimum rate of production of entropy. The constitutional supercooling acts as a bridge for this morphology change and still remains after the change.

S.Weintroub

539.2 : 548.5

TABULATED DATA ON CRYSTAL GROWTH OF 49 PIEZOELECTRIC SUBSTANCES. See Abstr. 641

539.2 : 548.5

1882 OSCILLATORY CHARACTER OF THE DISTRIBUTION OF AN IMPURITY ALONG THE LENGTH OF A GROWING SINGLE CRYSTAL. A.I.Landau.

Fiz. Metallov i Metallovedenie, Vol. 6, No. 1, 148-56 (1958).
In Russian.

The progress of orientated crystallization from the melt was studied. The graph of impurity distribution along the length of a single crystal was not, as would be expected, monotonous, but oscillatory — indicating stratified impurity distribution. Possible causes of this are discussed, and an attempt is made to establish a qualitative phenomenological theory for the case in which the impurity distributionis periodic.

539.2 : 548.5

1883 POSSIBLE CAUSES OF INHOMOGENEOUS DISTRIBUTION OF IMPURITIES IN A CRYSTALLINE INGOT.

B.N.Aleksandrov, B.I.Verkin, I.M.Lifshits and G.I.Stepanova.
Fiz. Metallov i Metallovedenie, Vol. 6, No. 1, 167-8 (1958).
In Russian.

539.2 : 548.5

1884 ZONAL SPECIFICITY AND NONSPECIFICITY OF CERTAIN IMPURITIES DURING GROWTH OF SYNTHETIC α-QUARTZ. A.J.Cohen and E.S.Hodge.

J. Phys. Chem. Solids, Vol. 7, No. 4, 361-2 (Dec., 1958).

Emission analyses were carried out on two quartz crystals grown from NaOH solution containing GeO_2. It is concluded that: (a) Ge replacing Si substitutionally is incorporated uniformly throughout the lattice; (b) trivalent Al replacing Si substitutionally tends to concentrate in certain growth zones; (c) the incorporation of certain impurities influences that of others, e.g. trivalent impurities affect the incorporation of Li and Na.

B.T.M.Willis

539.2 : 548.5

1885 INVESTIGATION OF SWELLING OF CAPRONE USING POLARIZED INFRARED LIGHT. B.Z.Volchek.

Fiz. tverdogo Tela, Vol. 1, No. 5, 803-7 (May, 1959). In Russian.

The degree of crystallization of caprone increases as a result of swelling in methyl alcohol or in dilute formic acid. Removal of the solvent by evacuation does not lower the degree of crystallization. These phenomena are explained by assuming that a partially crystallized polymer is in an unstable condition.

Z.Krasucki

539.2 : 548.5

1886 INTERFEROMETRIC DETERMINATION OF TWIST AND POLYTYPE IN SILICON CARBIDE WHISKERS.

D.R.Hamilton.
J. appl. Phys., Vol. 31, No. 1, 112-16 (Jan., 1960).

Whiskers of hexagonal SiC have been prepared in a graphite tube furnace. They are grown by sublimation of SiC in hydrogen, depositing at temperatures about 2000° C as acicular crystals of hexagonal section, with [0001] along the whisker length. The $\{1\bar{1}00\}$ faces have been examined using optical interference techniques, and are found to exhibit a twist. The Eshelby formula for twist caused by a screw dislocation has been used to estimate the strength of the associated Burgers vector. It is found that, within the experimental error, the estimated Burgers vector is equal to, or is an integral multiple of,the unit cell of the SiC polytype 4H. It is thus concluded that these twisted whiskers grow by means of a screw dislocation of integral strength parallel to the axis, and that they are of polytype 4H.

539.2 : 548.5

1887 NOVEL MECHANISM FOR MASS TRANSPORT DURING WHISKER GROWTH — CESIUM CHLORIDE FROM AQUEOUS FILMS. W.W.Webb and N.P.Bertolone.

J. appl. Phys., Vol. 31, No. 1, 207-9 (Jan., 1960).

Capillary rise of a saturated solution within a hollow whisker has been found to provide a mechanism yielding growth at the tips of caesium chloride whiskers on a moist substrate in air at room temperature. The driving force for crystal growth is local supersaturation due to evaporation of water from solution at the tip of the capillary pore in each whisker. Screw dislocations provide the lattice steps on the whisker tips.

539.2 : 548.5 : 541.12

1888 GROWTH MECHANISM OF COPPER WHISKERS BY HYDROGEN REDUCTION OF CUPROUS IODIDE.

C.R.Morelock and G.W.Sears.
J. chem. Phys., Vol. 31, No. 4, 926-8 (Oct., 1959).

A study of the process was made. Alternative mechanisms are proposed involving respectively vapour phase reduction and reduction at the whisker tip. A necessary consequence of the vapour phase reduction mechanism is the presence of a highly supersaturated copper vapour. It is shown that the vapour phase is not highly supersaturated in copper vapour and that reduction must occur heterogeneously. Furthermore, the reduction process occurs only at the tip and is most simply accounted for by assuming reduction at the step associated with an axial dislocation.

539.2 : 548.5

1889 STRENGTH OF LITHIUM FLUORIDE WHISKERS. G.W.Sears.

J. Phys. Chem. Solids, Vol. 6, No. 2-3, 298-300 (Aug., 1958).

A method of growing LiF whiskers is described. These were used in bend tests and for measurements of stress/strain curves in tension. The results indicate that LiF whiskers can be grown of strength approximating the theoretical prediction for a perfect crystal. Comparing this result with the findings of Gilman and Johnston [Abstr. 9037 of 1956, and Dislocations and Mechanical Properties of Crystals. New York: John Wiley (1957)], and assuming that a whisker approximates a large perfect crystal in regard to slip nucleation it is concluded that dislocation free regions of LiF crystals are not perfect regions.

J.Adam

539.2 : 548.5

1890 INFLUENCE OF SOLUBLE IMPURITIES ON STRENGTH OF PERFECT CRYSTALS. G.W.Sears.

J. Phys. Chem. Solids, Vol. 6, No. 4, 404-5 (Sept., 1958).

It is suggested that slip can be nucleated at a lower stress in perfect crystals if specific soluble impurities are present.

B.T.M.Willis

539.2 : 548.5

1891 DENDRITIC GROWTH OF GERMANIUM CRYSTALS.

A.I.Bennett and R.L.Longini.

Phys. Rev., Vol. 116, No. 1, 53-61 (Oct. 1, 1959).

Controlled dendritic growth of germanium from the melt yields long thin strips whose principal surfaces are optically flat $\{111\}$ crystallographic planes except for the occasional presence of small steps. The crystals grow rapidly in the $\langle 211\rangle$ direction, have twin planes parallel to the flat surfaces, and can withstand an elastic strain exceeding 10^{-3}. The distribution coefficients of impurities are close to unity compared to quasi-equilibrium values. A mechanism for dendritic growth is proposed, in which the presence of at least one properly oriented twin plane is fundamental and necessary. This mechanism explains most of the observed growth features in germanium dendrites, and is expected to apply generally to materials with the zincblende structure. The presence of the twin plane makes growth in opposite directions in the twin plane dissimilar, not only in the zincblende lattice but generally. The effect of the asymmetrization on the growth of α-SiC is considered. A crystal growth mechanism based on the asymmetrization is proposed, which should be of general validity.

539.2 : 548.5

1892 OBSERVATIONS ON THE DEVELOPMENT OF ELECTROPLATING DEPOSIT STRUCTURES ON SINGLE CRYSTALS OF COPPER.

V.R.Howes.

Proc. Phys. Soc., Vol. 74, Pt 5, 616-24 (Nov., 1959).

Results of step height measurements of layer structures on electrodeposits, on a copper single crystal surface with orientation close to a (100) plane, are shown by frequency distribution curves for increasing deposition times. Platelet layer width measurements are given for the same times. The results are associated with the concept of bunching. Observations are also described of a secondary topographical structure, detected by auxiliary microscope techniques, on the surfaces of the normal platelet layers; these are seen to be differentially tilted, curved and covered with micro-layers.

539.2 : 548.5

1893 GROWTH OF THIN LAYERS OF ALKALI HALIDE BY NUCLEATION, OBSERVED IN THE ELECTRON MICROSCOPE.

W.Wilkens.

Z. Naturforsch., Vol. 14a, No.3, 275-81 (March, 1959). In German.

Layers of alkali halide, evaporated on to freshly cleaved surfaces of alkali halide crystals and about 1000A thick, are found by electron microscopy to have relatively smooth surfaces in most cases. The only exceptions were films of LiF and NaF, which show crystallites a few hundred A in width. Formation of such crystallites, however, takes place in all cases if the receiving surface is first nucleated by evaporation of a very small amount of some foreign substance, such as WO_3, LiF or certain metals. Detailed investigation of this nucleation process has been carried out for KCl deposition on a KCl crystal, with LiF as nucleator. The number of crystallites formed was found to increase with the rate of evaporation of the LiF.

V.E.Cosslett

539.2 : 548.5

1894 THE GROWTH OF NICKEL OXIDE ON SPHERICAL SINGLE CRYSTALS OF NICKEL WITH SMOOTH, UNTOUCHED SURFACES.

M.Otter.

Z. Naturforsch., Vol. 14a, No. 4, 355-61 (April, 1959). In German.

Spherical single crystals of nickel were produced by solidifying a drop of molten nickel in high vacuum. The crystals were then heated in oxygen to form oxide layers. These layers grew at a rate strongly dependent on the orientation of the underlying metal, with the most rapid growth along the great circle normal to [100]. Epitaxial phenomena were observed at isolated points of the sphere.

B.T.M.Willis

539.2 : 548.5

1895 DIMENSIONAL CHANGES IN SINGLE CRYSTALS OF SYNTHETIC SAPPHIRE AFTER IRRADIATION.

D.G.Martin.

J. Phys. Chem. Solids, Vol. 10, No. 1, 64-5 (April, 1959).

Single crystal of sapphire were irradiated by γ-rays, X-rays and electrons without any dimensional changes being observed on a mechanical comparator of magnification 4500, although the colour was changed to very pale yellow. Neutron irradiation, on the other hand, produced a dark brown coloration with an increase in length of up to about 500 p.p.m., the expansion along the c-axis being noticeably less than that at right angles to this axis. Difficulties in the interpretation of the results are discussed.

J.Thewlis

539.2 : 548.5

1896 CONTRIBUTION TO THE STUDY OF THE CHEMICAL ATTACK AND OXIDATION OF ORIENTATED SURFACES OF SINGLE CRYSTALS OF GERMANIUM.

L.Gouskov and N.Nifontoff.

C.R. Acad. Sci. (Paris), Vol. 248, No. 10, 1499-502 (March 9, 1959). In French.

Describes the appearance of $\{001\}$, $\{110\}$ and $\{111\}$ faces after etching in H_2O_2 and after subsequent treatment at an elevated temperature in an atmosphere of dry oxygen. The peroxide leaves no visible oxide film. Oxidation at 300-500° C produces a coloured oxide film, at more than 500° C a granular oxide film on the raised regions of the peroxide etch pattern, and at still higher temperatures a granular film over the whole surface. The different faces oxidize in detail in different ways. Seven photomicrographs.

W.Bardsley

539.2 : 548.5

1897 ETCH FIGURES OF DEFORMATION TWINS IN CALCITE.

R.I.Garber and E.I.Stepina.

Dokl. Akad. Nauk SSSR, Vol. 128, No. 3, 499-501 (Sept. 21, 1959). In Russian.

Force was applied by a wedge near a plane surface so that a twin emerged on the glide plane. Photographs of etch figures are given.

R.Berman

539.2 : 548.5

1898 ION-BOMBARDMENT ETCHING OF SILICON AND GERMANIUM.

J.A.Dillon, Jr and R.M.Oman.

J. appl. Phys., Vol. 31, No. 1, 26-8 (Jan., 1960).

Electron-microscope photographs of a germanium single crystal surface subjected to prolonged argon-ion bombardment under conditions used for surface cleaning disclosed etch patterns of a type completely different from those observed after chemical etching alone. The dimensions and distribution of the bombardment-induced pits were such that the patterns were not detectable either with an optical microscope or by low-energy electron diffraction. Approximately 95% of the surface remained undamaged. Bombardment of silicon and germanium at 500 eV for prolonged periods at higher current densities produced a different type of etching which may be associated with screw-type dislocations.

539.2 : 548.5

1899 SHAPES OF ETCH HILLOCKS AND PITS AND THEIR CORRELATION WITH MEASURED ETCH RATES.

B.A.Irving.

J. appl. Phys., Vol. 31, No. 1, 109-11 (Jan., 1960).

The factors which govern the occurrence and stability of etch hillocks and pits have been examined. Batterman's origin analysis has been reconsidered and extended to account for all the crystallographic facets of etch hillocks and pits produced by a dilute hydrogen peroxide-hydrofluoric acid etchant on germanium surfaces. The treatment should be valid for other etchants and materials but suitable data are not available.

539.2 : 548.5

1900 PITS ON GERMANIUM SURFACE FORMED BY MOLTEN INDIUM.

S.-I.Denda.

J. Phys. Soc. Japan, Vol. 13, No. 5, 533 (May, 1958).

At 350° C for 2 minutes the pits resemble those formed by CP-4, while at 200° C they resemble those formed by superoxol. Observations were made on the $\{111\}$ plane. Three plates.

W.Bardsley

539.2 : 548.5

1901 RESISTANCE OF POLISHED ROCK SALT SURFACES TO WATER VAPOUR.

F.Asselmeyer and H.Riedel.

Z. angew. Phys., Vol. 11, No. 3, 114-17 (March, 1959). In German.

A study was made of the influence of crystallographic direction, temperature, and relative humidity. The resistance of a surface to attack by water vapour was assessed by measuring the opacity of the surface to normally incident light.

J.Thewlis

539.2 : 548.5

1902 THE DETECTION OF DISLOCATIONS IN GERMANIUM WITH X-RAYS. V.Gerold and F.Meier.
Z. Phys., Vol. 155, No. 4, 387-94 (1959). In German.

An X-ray method was used to study the distribution of dislocations in germanium crystals. The majority of the dislocations were in (111) planes. The Burgers vector, when it could be determined, was in the same plane as the dislocation. B.T.M.Willis

539.2 : 548.7

1903 AN OPTICAL METHOD OF STUDYING THE DIFFRACTION FROM IMPERFECT CRYSTALS. III. LAYER STRUCTURES WITH STACKING FAULTS. B.T.M.Willis.
Proc. Roy. Soc. A, Vol. 248, 183-98 (Nov. 11, 1958).

For Pt II, see Abstr. 6722 (1957). The reciprocal lattice intensity distribution has been determined quantitatively using a photomultiplier to measure the optical diffraction intensities. The systems examined included the simple-cubic structure with "wollastonite-type" stacking faults, the close-packed-hexagonal structure with growth faults, and the face-centred-cubic structure with deformation faults on one set and on two sets of $\{111\}$ planes. It is shown that the Paterson (1952) analysis of the diffraction from deformation faulted f.c.c. crystals can be extended to intersecting faulted $\{111\}$ planes, provided that the faulting parameter, α, is not greater than about 0.1. The main limitation of the optical method concerns the restriction in the number of layers (10^3) which can be conveniently represented in one grating. This restriction gives rise to weak fluctuations in the observed intensity distribution and to an uncertainty of up to 0.03 in the determination of α from this distribution.

539.2 : 548.7

1904 SELF-ADJUSTMENT OF INTERNAL RADIATION FIELD TO COMPENSATE FOR LINEARLY VARYING D SPACING IN X-RAY DIFFRACTION. H.Cole and G.E.Brock.
Phys. Rev., Vol. 116, No. 4, 868-73 (Nov. 15, 1959).

It is now well known from studies of "anomalous transmission" that the energy flow through a perfect crystal during symmetric Laue (transmission) diffraction is along the diffracting planes. If the planes are then fanned out, as in elastic bending, the question arises as to whether or not the radiation pattern can adapt itself to the changing d spacing so as to maintain diffraction conditions. If it does, the exit Bragg angle should differ from the entrance Bragg angle by an amount proportional to the bend. Experimental evidence is presented to show that this is indeed the case. Germanium crystals, judged to be perfect because of lack of etch pits, were used. Various anomalies in the transmitted intensities indicate that defects still exist.

539.2 : 548.7

1905 STUDY OF THE SUBSTITUTION OF SILICON IN SEVERAL TYPES OF ORTHOSILICATES.
A.Durif-Varàmbon.
Bull. Soc. Franc. Mineral. Crist., Vol. 82, No. 7-9, 285-314 (July-Sept., 1959). In French.

A crystallographic study of the substitution of Si by Ge in three classes of orthosilicates: (a) SiO_4M, (M = Zr, Th, U), typified by zircon and monazite; (b) SiO_4M_2, (M = Be, Zn, Co, Ni, Fe), typified by olivine and phenacite; (c) $(SiO_4)_3Bi_4$. In class (a) GeO_4M compounds with the scheelite structure are formed. In (b) the compounds formed are germanates GeO_4M_2, which are normal spinels for M = Fe, Ni, Co, Mg. The spinel-olivine and spinel-phenacite transitions were studied in mixed germanates; solid solutions of germanate and ferrite spinels were found to have magnetic properties in accordance with Néel's theory. In (c) isomorphous substitution occurs. Substitution of SiO_4 by XO_4($X = Cr^{6+}$, S^{6+}, P^{6+}, As^{5+}) was investigated in classes (a) and (c). Nine new (a) and fourteen new (c) compounds were formed. B.T.M.Willis

539.2 : 548.7

1906 CRYSTALLOGRAPHIC EVIDENCE FOR THE EXISTENCE OF B_7O. R.A.Pasternak.
Acta cryst., Vol. 12, Pt 8, 612-13 (Aug., 1959).

Sharp X-ray powder photographs were obtained, indicating an orthorhombic unit cell, a = 8.20, b = 5.35, c = 5.13 A, and the density agrees with four molecules of B_7O per unit cell. The structure appears to be similar to that of boron. A.R.Stokes

539.2 : 548.7

1907 PREPARATION AND CRYSTALLOGRAPHIC DATA OF $CaCO_3.H_2O$. F.Lippmann.
Naturwissenschaften, Vol. 46, No. 19, 553-4 (1959). In German.

Crystals were prepared by slow precipitation from mixed aqueous solution. A hexagonal cell (a = 10.62 A, c = 7.54 A), containing 9 molecules, was found. Refractive indices $n_e = 1.543$; $n_o = 1.590$. A.R.Stokes

539.2 : 548.7

1908 α- AND β-$ZnCl_2$.
B.Brehler.
Naturwissenschaften, Vol. 46, No. 19, 554 (1959). In German.

α-$ZnCl_2$ is tetragonal with a = 5.40 A and c = 10.35 A; β-$ZnCl_2$ is monoclinic with a = 6.54 A, b = 11.31 A, c = 12.33 A and $\beta = 90^0$. In the α-form, the Cl's are approximately in a cubic close-packed arrangement (for ideal close packing c/a = 2), and in the β-form they are approximately in a hexagonal close-packed arrangement. In both forms the Zn's occupy a quarter of the tetrahedral holes in the Cl framework. B.T.M.Willis

539.2 : 548.7

1909 THE MEASUREMENT OF THE LATTICE EXPANSIONS AND DEBYE TEMPERATURES OF TITANIUM AND SILVER BY X-RAY METHODS. J.Spreadborough and J.W.Christian.
Proc. Phys. Soc., Vol. 74, Pt 5, 609-15 (Nov., 1959).

A high temperature diffractometer was used to determine the lattice spacing—temperature relations for both α- and β-titanium. For α-titanium, the mean coefficients of thermal expansion over the temperature range 0-600°C are 9.55×10^{-6} deg^{-1} for the a spacing, and 10.65×10^{-6} deg^{-1} for the c spacing; for β-titanium, the mean expansion coefficient over the temperature range 900-1070°C is about 12.0×10^{-6} deg^{-1}. The temperature variation of the (peak) intensities of diffracted powder lines for silver is in agreement with Debye—Waller theory, after applying a correction due to Paskin [Acta cryst., Vol. 10, Pt 10, 667-9 (Oct., 1957)], and corresponds to a Debye temperature of 197°K. Corresponding results for α-titanium indicate that the Debye temperature is about $270^0 \pm 30^0$K. Analysis of the line shapes of cold-worked titanium indicates an appreciable density of basal plane stacking fault.

539.2 : 548.7

1910 ANISOTROPIC BROADENING OF X-RAY DIFFRACTION MAXIMA OF SOLID SOLUTIONS OF COPPER AFTER DEFORMATION. L.N.Guseva and A.A.Babaréko.
Dokl. Akad. Nauk SSSR, Vol. 124, No. 4, 789-91 (1959). In Russian.

Deformation of metals causes anisotropic distortion of the crystallites which in turn causes anisotropic line broadening of the diffraction pattern. Measurement of this effect is briefly reported. T.Mulvey

539.2 : 548.7

1911 LATTICE DISTORTION OF GRAPHITE DURING MECHANICAL DISPERSION. L.A.Feigin.
Dokl. Akad. Nauk SSSR, Vol. 127, No. 2, 313-15 (July 11, 1959). In Russian.

The X-ray diffraction patterns of milled graphite were studied. The patterns in many cases are indistinguishable from those of coal and soot. J.K.Skwirzynski

539.2 : 548.7

1912 INVESTIGATION, BY MEANS OF NARROW PRIMARY X-RAY BEAMS, OF THE RECRYSTALLIZATION OF PURE Cu [99.99%]. V.I.Arkharov and F.L.Shangareev.
Fiz. Metallov i Metallovedenie, Vol. 6, No. 1, 172-3 (1958). In Russian.

The Cu was deformed by rolling to 75% and to 50%. High-temperature annealing was carried out in an evacuated quartz tube; low-temperature annealing, in air. After each annealing, the Cu was examined using a narrow X-ray beam. The onset of recrystallization is indicated by broken Debye lines.

539.2 : 548.7

1913 X-RAY INVESTIGATION OF SWELLING IN CRUDE RUBBER. L.A.Volkova and M.V.Vol'kenshtein.
Fiz. tverdogo Tela, Vol. 1, No. 8, 1272-8 (Aug., 1959). In Russian.

X-ray diagrams of crude rubber swollen to different degrees in kerosene show that the interplanar distance is independent of the degree of swelling. The crystallinity increases with small degrees of swelling, and with further swelling decreases, ultimately to zero. The results are interpreted in terms of the non-equilibrium state of polycrystalline polymers. R.F.S.Hearmon

539.2 : 548.7 : 539.19

1914 EXPLORATORY STUDY, BY LOW-TEMPERATURE X-RAY DIFFRACTION TECHNIQUES, OF DIBORANE AND THE PRODUCTS OF A MICROWAVE DISCHARGE IN DIBORANE.

L.H.Bolz, F.A.Mauer and H.S.Peiser.

J. chem. Phys., Vol. 31, No. 4, 1005-7 (Oct., 1959).

It has been suggested that atomic hydrogen may form a loose, one-electron bond with stable electron-deficient molecules such as diborane (B_2H_6). Such bonding might make possible the stabilization of quasi-atomic hydrogen at higher temperatures or in higher concentrations than have been attained previously. To test this theory, diborane and the products of a microwave discharge in diborane have been studied by X-ray diffraction in the temperature range 4.2° to 100° K. Two structurally related phases have been distinguished in ordinary diborane. The low temperature or α phase is formed by deposition from the gas at 4.2° K. It transforms slowly to β diborane above 60° K. The β phase is also obtained by depositing at 77° K and annealing above 90° K to eliminate traces of the α phase. An additional phase is found in specimens formed by freezing at 4.2° K the products of a microwave discharge in diborane. It is probably a boron-hydrogen compound with a triple point temperature of about 60° K. It may be BH_3. This compound is not known definitely, but some evidence for its existence has been reported. In each experiment with "discharged" diborane, warm-up began with a sudden increase in temperature from 4.2° to about 33° K while there was still helium in the Dewar. The source of heat has been traced to hydrogen frozen out with diborane and other products of the microwave discharge. The temperature rise, which may have been initiated by a process such as recombination of atomic hydrogen trapped in the solid, was sustained by heat transferred from the Dewar walls by hydrogen gas released from the sample. Since the heat release occurred spontaneously at a temperature near 4.2° K it cannot be concluded that diborane helped appreciably to stabilize atomic hydrogen in the solid.

539.2 : 548.73 : 538.27

STRUCTURE OF AsI_3 AND $AsI_3.3S_8$. See Abstr. 686

539.2 : 548.7

1915 SCATTERING FACTOR FOR OUTER ELECTRONS IN ORDERED Fe_3Al.

Y.Komura, Y.Tomiie and R.Nathans.

Phys. Rev. Letters, Vol. 3, No. 6, 268-9 (Sept. 15, 1959).

X-ray measurements on single crystals indicate the presence of six 3d-electrons in the Fe-atoms in this ordered alloy. Since magnetic scattering data show that no large difference in the 3d shell configuration may be expected between Fe atoms in Fe_3Al and free Fe atoms, the result disagrees with Weiss and De Marco's low value (2.3 ± 0.3 3d-electrons) (Abstr. 3583 of 1958). L.Pincherle

539.2 : 548.73

1916 GAS-CRYSTALLINE STATE OF MATTER IN POLYMERS.

A.I.Kitaigorodskii.

Dokl. Akad. Nauk SSSR, Vol. 124, No. 4, 861-4 (1959). In Russian.

A substance is said to be in gas-crystalline state when centres of molecules forming the substance are disposed on a regular space lattice while the orientations of molecules are not ordered. An X-ray diffraction pattern of a substance in gas-crystalline state will consist of one to three sharp equatorial reflections and will show a steep drop in intensity of reflections. A transition to gas-crystalline state should cause sharpening of nuclear magnetic resonance lines and it is suggested that the effect observed by Holroyd et al. (Abstr. 6550 of 1951) in polystyrene at temperatures above 110° C is due to such a transition. X-ray diffraction results indicate that polyacrylonitrile is in gas-crystalline state. J.Adam

539.2 : 548.73

1917 THE PROBLEM OF THE INFLUENCE OF NEUTRON IRRADIATION ON THE FINE CRYSTAL STRUCTURE OF METALS AND ALLOYS.

I.V.Batenin, V.A.Il'ina, V.K.Kritskaya and B.V.Sharov.

Fiz. Metallov i Metallovedenie, Vol. 7, No. 2, 243-6 (1959). In Russian.

Specimens of Fe, Cr, Ni, Cu and of the alloys Fe—Ni, Fe—Cr, Fe—Mn and Fe—W were exposed to 10^{20} n/cm^2 at temperatures < 80° C. X-ray diffraction lines were found to be greatly broadened due to refinement of the size of regions of coherent scattering and to the development of stresses in the lattice. 19 references. [English Summary: PB 141126T-9, obtainable from Office of Technical Services, U.S. Dept. of Commerce, Washington, D.C., U.S.A.]. A.F.Brown

539.2 : 548.73 : 535.33

EFFECT OF NITROGEN IMPURITIES ON THE STRUCTURE OF TYPE I DIAMOND. See Abstr. 652

539.2 : 548.73

1918 DEVELOPMENT AND COMPARISON OF TWO X-RAY METHODS FOR DETERMINING THE CRYSTALLINITY OF COTTON CELLULOSE.

J.H.Wakelin, H.S.Virgin and E.Crystal.

J. appl. Phys., Vol. 30, No. 11, 1654-62 (Nov., 1959).

The methods, which use a Geiger counter spectrometer, were applied to six native cotton varieties, to a cross-bred variety, and to two cottons chemically modified with ethylamine. The X-ray scattering curves for each of the nine samples were compared with those from a highly crystalline sample, a cotton hydrolyzed in HCl, and an amorphous cotton sample to provide a relative measure of crystallinity, or crystalline index. With fully corrected data the average crystalline index of the six cotton varieties was found to be 68.3 and 78.7% by the correlation and by integral methods, respectively. The crystalline indices of the remaining samples determined by the correlation and by the integral methods are, respectively, cross-bred cotton (S × P), 54.3 and 77.2%; cotton treated with anhydrous ethylamine, 29.7 and 50.9%; and cotton treated with 75% aqueous ethylamine, 28.3 and 50.3%.

539.2 : 548.73

1919 ABSORPTION CORRECTION IN PRECISION DETERMINATION OF LATTICE PARAMETERS.

M.E.Straumanis.

J. appl. Phys., Vol. 30, No. 12, 1965-9 (Dec., 1959).

X-ray powder and rotation patterns of six cubic substances (W, Si, Cr, TiO, Al, and V) using specimens of different thickness were made; the patterns were measured, the lattice constants calculated and plotted against the θ angle or against the Nelson and Riley function. Such curves for thin mounts, semitransparent to X-rays (below 0.2 mm in diam.), consist of two parts: a region of high slope (due to absorption) and one approaching a zero slope at high Bragg angles. The latter, varying in extent with the size and nature of the mount, indicates that due to the rapid decrease in absorption, the lines in this region are shifted, little if any, from their correct positions. Hence, lattice constants calculated from the reflections of the high θ angles lying on the horizontal portion of the curve need not be corrected for absorption. The constant, with negligible error, can be calculated from a single last strong α_1 or β reflection. If an extrapolation is applied, the curve must be traced through points in the high back reflection region. Otherwise any extrapolation, disregarding the horizontal part, would lead to lattice constants too high in value. The amount of line displacement due to absorption in thin samples (below 0.2 mm diam.) agrees with the geometrical concept of Hadding and Buerger.

539.2 : 548.73

1920 TEMPERATURE DIFFUSE SCATTERING [TDS] OF X-RAYS IN CUBIC POWDERS. I. COMPARISON OF THEORY WITH EXPERIMENT.

D.R.Chipman and A.Paskin.

J. appl. Phys., Vol. 30, No. 12, 1992-7 (Dec., 1959).

A study of the reliability of current TDS theory. Measurements are reported of the diffuse scattering of copper and lead along with the Bragg reflections of these metals at room and liquid nitrogen temperatures. These measurements were made using a scintillation counter diffractometer and crystal monochromated CuKα radiation. The TDS so obtained is compared with TDS calculations based on the one- and two-phonon calculation as well as on the Warren (modified one-phonon) calculation. Both formulae are found to fit the magnitude of TDS by choosing appropriate Debye characteristic temperatures. The Debye Θ's which fit the copper and lead TDS data at room temperature are: 324° and 96° (one- and two-phonon) and 269° and 64° (Warren formula) as compared to values of 307° and 79° taken from the temperature dependence of the Bragg reflections and 315° and 88° from specific heat values for copper and lead, respectively. Evidence is also found for extra diffuse scattering in the low-angle region. This extra scattering is tentatively ascribed to a multiple scattering process.

539.2 : 548.73

1921 TEMPERATURE DIFFUSE SCATTERING [TDS] OF X-RAYS IN CUBIC POWDERS. II. CORRECTIONS TO INTEGRATED INTENSITY MEASUREMENTS.

D.R.Chipman and A.Paskin.

J. appl. Phys., Vol. 30, No. 12, 1998-2001 (Dec., 1959).

In order to obtain accurate values for the integrated Bragg intensities, it is necessary to correct for the fact that TDS peaks in the same regions of reciprocal space in which Bragg peaks occur. On the basis of recent calculation of TDS in cubic powders it is possible to calculate the contribution of TDS to apparent measured Bragg intensities. Measurements were made on a counter spectrometer using crystal-monochromated CuKα radiation. The contribution of TDS to the measured Bragg intensities is demonstrated on several peaks of lead. A simple relationship is derived for the correction and compared with a graphical solution obtained by plotting TDS under the Bragg peak. The agreement between the two methods of correcting for TDS is good. The magnitude of the correction varies with the material, the wavelength of the X-rays and the region of reciprocal space studied. For a typical material such as copper using copper radiation, the correction is about 3% of the integrated intensity. For lead, again using copper radiation, it is about 15%.

539.2 : 548.74 : 538.2

NEUTRON STUDY OF THE CRYSTAL STRUCTURE OF $MnFe_{2-t}Cr_tO_4$. See Abstr. 1797

539.2 : 548.73

1922 PLANARITY OF 1:2-4:5-TETRABROMOBENZENE MOLECULE. G.Gafner and F.H.Herbstein.
Molecular Phys., Vol.1, No.4, 412-14 (Oct., 1958).

A three-dimensional analysis of the crystal structure of 1:2-4:5-tetrabromobenzene shows that within the limits of error the molecule is planar. Since this compound is isomorphous with the corresponding tetrachlorobenzene it is concluded that the latter molecule too is planar. This is contrary to the results deduced from electron-diffraction measurements. W.J.Orville-Thomas

VARIOUS SOLID STRUCTURES

539.213

1923 LOW MELTING SULFIDE-HALOGEN INORGANIC GLASSES. S.S.Flaschen, A.D.Pearson and W.R.Northover.
J. appl. Phys., Vol. 31, No. 1, 219-20 (Jan., 1960).

A preliminary report of a new family of glasses in the ternary system As—S—I. The glasses are similar in major properties to those previously reported As—Tl—S—Se systems [same authors, Journal of the American Ceramic Society, Vol. 42, 450 (1959)]. They are insoluble in water, acids and weak bases, but are decomposed by strong alkali and oxidising agents. They are insulators with resistivities at 25°C in excess of 10^{13} ohm.cm, and have remarkably low melting points. Phase diagrams indicating the glass formation region, the 30 poise viscosity temperatures, and softening points of the glasses, are given. S.Weintroub

539.213

1924 DISLOCATION TYPE DEFECTS IN GLASS. W.C.Levengood and T.S.Vong.
J. chem. Phys., Vol. 31, No. 4, 1104-10 (Oct., 1959).

For previous work see Abstr. 7531 of 1959. Flaws formed on freshly broken surfaces of glass reacted to various types of applied stress in a manner suggestive of dislocation type defects. Localized shear stresses caused existing defects to disappear and created new flaws which formed a cyclic pattern between parallel scratches made on newly created surfaces. These flaws formed behind the scratching tool and appeared to be associated with harmonically moving stress waves in the glass. Thermally induced stress energies were also found to increase the probability of flaw formation. Matching flaws were produced by nonuniform cohesional forces between internal crack surfaces. This effect was interpreted as the result of limited moisture penetration causing zones of reaction products and localized stress concentrations. The morphology of the defects indicated a dislocation within the glass which produced slip lines on the surface. The critical shear stress found to affect the flaws was determined by loading with spherical indenters.

539.217

1925 THERMAL STABILITY OF CARBON ELECTRODES IN CONTACT WITH CRYSTALLINE LAYERS OF CADMIUM SULPHIDE. M.H.Boisot, G.Cohen-Solal, and F.Teissier du Gros.
C.R.Acad. Sci. (Paris), Vol. 249, No. 21, 2184-6 (Nov. 23, 1959). In French.

Satisfactory electrodes for polycrystalline CdS layers were made by evaporating carbon from a spectrographically pure rod. The effects of heat treatment on the photosensitive properties of the layers were then studied. It was seen that layers which were given a 2hr vacuum bake at 500°C before the electrodes were applied behaved in the same way as layers which were heat-treated with the electrodes already in position. This indicates that no appreciable diffusion of the carbon takes place, and that such electrodes would be convenient for studying the effects of adding impurities. C.Hilsum

539.219 : 535.3 : 539.2

PHASE COMPOSITION AND STRUCTURE OF Cu—Sn ALLOYS. See Abstr. 1718

539.219

1926 ON A PROPOSAL FOR THE MEASUREMENT OF PHASE CHANGES AT HIGH PRESSURES. F.Fraunberger.
Ann. Phys. (Leipzig), Folge 7, Vol. 4, No. 1-5, 225-8 (1959). In German.

The high frequency resistance has been measured of a small coil with a core consisting of five short steel wires of 20 mm. length and 1 mm. diameter. Use has been made of the change in magnetic permeability accompanying a phase change (from perlite to α-iron and ferrite) with a small coil which takes up little room in a pressure chamber and where insulation problems at higher temperatures do not arise, because the number of turns is very small. R.Schnurmann

539.219

1927 ON MAKING VISIBLE DISLOCATIONS AT THE SUB-GRAIN BOUNDARIES OF Fe-Cr ALLOYS BY ION BOMBARDMENT. A.Mašín and V.Havel.
Acta phys. Hungar., Vol. 9, No. 4, 471-4 (1959). In German.

Fe alloys containing 24% Cr, 0.14% C, 0.65% Si and 0.04% Mn were bombarded by ions after being hardened in water at 1100° C in an attempt to discover why some dislocations are made visible and others remain undetected. It was found that, in the material examined, dislocations were visible only in regions free from appreciable segregations of carbide. J.Thewlis

539.219

1928 CRYSTAL-OPTICAL STUDIES OF POLYCRYSTALLINE FERROELECTRICS IN THE $BaTiO_3-ZrO_2$ SYSTEM. T.N.Burakova and T.N.Verbitskaya.
Dokl. Akad. Nauk SSSR, Vol. 126, No. 5, 994-6 (June 11, 1959). In Russian.

$BaTiO_3-ZrO_2$ solid solutions with up to 20 mol.% of ZrO_2 were prepared by firing at 1380-1400°C. At room temperature they were found to consist of several phases: (a) an anisotropic birefringent light-brown phase, which was the main component of $BaTiO_3$ and of the solid solutions with up to 12% ZiO_2; (b) an isotropic cubic phase which appears at 15% of ZrO_2 and by 20% of ZrO_2 replaces completely the (a) phase; (c) a second anisotropic phase, also of light-brown colour, which fills up the spaces between grains of (a) or (b) and which is monocrystalline, biaxial and birefringent; and (d) a brown-grey glassy or finely dispersed phase, present in small amounts. A.Tybulewicz

539.219

1929 A THEORY OF THE NUCLEATION OF NEW PHASES ON THE DECAY OF SOLID SOLUTIONS. L.S.Palatnik and V.S.Zorin.
Dokl. Akad. Nauk SSSR, Vol. 126, No. 6, 1254-7 (June 21, 1959). In Russian.

A theoretical analysis of nucleation shows that it should be possible to decide on the origins of the differences in the mechanisms of natural and artificial ageing (of Al—Cu alloys, for example) from the various representations of the character of the nucleation of centres of transformation which are discussed. A.L.Mackay

539.219

1930 NATURE OF THE DEPENDENCE OF THE MECHANICAL PROPERTIES OF SOLID SOLUTIONS ON THEIR CONCENTRATIONS. M.B.Makogon.
Fiz. Metallov i Metallovedenie, Vol.5, No.2, 318-25 (1957). In Russian.

It was established that the course of the curves of the deformation resistance versus composition for low-melting alloys depends to a considerable extent on the deformation conditions (rate and extent of straining) A discussion is also presented of the applicability of Kurnakov's rules to the dependence of the mechanical properties on the composition of the solid solutions.

539.219

1931 EFFECT OF THE STATIC ["FROZEN-IN"] STRAINS OF THE CRYSTAL LATTICE ON THE MECHANICAL PROPERTIES OF Al–Mg ALLOYS. I. DEPENDENCE OF YIELD STRENGTH AND TENSILE STRENGTH ON THE TEMPERATURE AND ON THE DEFORMATION RATE.

A.V.Grin', V.A.Pavlov and I.A.Pereturina.
Fiz. Metallov i Metallovedenie, Vol. 5, No. 3, 493-500 (1957).
In Russian.

Studied from 80° to 700°K, for changes of the deformation rate in the range 1 : 10^3. It was established for pure Al that, up to 500°K, the relation between the yield strength and the elasticity modulus is virtually temperature independent. Above this temperature, a more pronounced temperature dependence was observed, linked with the deformation processes at the grain boundaries. The strengthening of the Al by Mg is due to frozen-in strains of the crystal lattice, caused by Mg atoms. Diffusion processes occurring when the alloy is deformed strongly affect the yield strength.

539.219

1932 EFFECT OF THE STATIC ["FROZEN-IN"] STRAINS OF THE CRYSTAL LATTICE ON THE MECHANICAL PROPERTIES OF Al–Mg ALLOYS. II. DEPENDENCE OF TOTAL AND UNIFORM DEFORMATION ON TEMPERATURE AND DEFORMATION RATE.

A.V.Grin', V.A.Pavlov and I.A.Pereturina.
Fiz. Metallov i Metallovedenie, Vol. 6, No. 1, 110-15 (1958).
In Russian.

Studied from 80° to 700°K, for changes of the deformation rate in the range 1 : 10^3. It was shown that the frozen-in strains of the lattice reduce the plasticity. Diffusion processes increase the plasticity of the alloy and complicate the temperature dependence of the total and uniform deformation.

539.219

1933 INTERNAL FRICTION PEAKS IN Ni–Cr BASED SOLID SOLUTIONS.

Yu.S.Araamov, L N.Belyakov and B.G.Livshits.
Fiz. Metallov i Metallovedenie, Vol. 6, No. 1, 116-21 (1958).
In Russian.

Ni–Cr and Ni–Cr–Ti–Al alloys, which have been tempered after quenching, exhibit anomalous ageing effects (modification of all the physical properties, including hardness), although the equilibrium diagrams indicate that the alloys are single phase. This anomalous ageing was studied in terms of the temperature dependence of the internal friction of the alloys. In Ni–Cr–Ti–Al, an internal-friction peak was observed which is attributed to the presence of the Ti atoms It is concluded that the friction-peak method can be used to analyse transformations in substitutional solid solutions, even at low solute concentrations.

539.219

1934 THE CHARACTER OF INTERATOMIC BOND FORCES IN Fe–Al ALLOYS.

S.A.Nemhohov and K.M.Kolobova.
Fiz. Metallov i Metallovedenie, Vol. 6, No. 1, 183-5 (1958).
In Russian.

539.219

1935 DETERMINATION OF THE ACTIVATION ENERGY OF THE REARRANGEMENT PROCESSES DURING PHASE TRANSFORMATIONS IN SOLID SOLUTIONS.

L.N.Aleksandrov.
Fiz. Metallov i Metallovedenie, Vol. 5, No. 2, 370-1 (1957).
In Russian.

539.219

1936 THE VIBRATIONAL FREQUENCY SPECTRUM FOR THE SIMPLEST MODEL OF AN ORDERING ALLOY. II.

A.N.Men' and A.N.Orlov.
Fiz. Metallov i Metallovedenie, Vol. 7, No. 3, 335-40 (1959).
In Russian.

In Pt I (Abstr. 4764 of 1954) the vibration spectrum was calculated for a lattice consisting of two kinds of atoms of almost the same mass, distributed on lattice points with a degree of long range order η. The elastic constant between neighbouring atoms was assumed to be independent of what kind they were. In the present paper, the elastic moduli are allowed to vary slightly for bonds between neighbouring atoms of different kinds. The maximum(Debye) vibrational frequency is found to increase or decrease with degree of long range order depending on the relative masses of the atoms and on the relative strength of the bonds between them.

A.F.Brown

539.219

1937 AN INVESTIGATION OF THE ELECTRON SPECTRUM OF DILUTE SOLID SOLUTIONS.

I.B.Borovskii and K.P.Gurov.
Fiz. Metallov i Metallovedenie, Vol. 7, No. 2, 225-34 (1959).
In Russian.

The fine structure of the X-ray absorption spectrum of Cr–Mo and Pb–Sn alloys was studied for a range of compositions. Results are analysed to see how addition of small amounts of impurities affects the binding energy and electron energy levels in metals having an unfilled energy band. [English summary: PB 141126T-9, obtainable from Office of Technical Services, U.S. Dept. of Commerce Washington, D.C., U.S.A.].

A.F.Brown

539.219

1938 THE INFLUENCE OF ALLOYING ADDITIONS ON THE STRENGTH OF INTERATOMIC BINDING IN THE ALUMINIUM LATTICE. I. THE INFLUENCE OF COPPER

G.P.Kushta, I.P.Mikhailyuk and G.F.Korolyuk.
Fiz. Metallov i Metallovedenie, Vol. 7, No. 2, 299-301 (1959).
In Russian.

A method is described whereby the Debye temperature (Θ) and the mean square amplitude of atomic oscillation ($\overline{u^2}$) can be calculated from the photometric measurement of the relative intensities of X-ray lines at 20°C and −183°C. Tables give the variation of Θ and $\overline{u^2}$ as the Cu content of Al is raised from 0-4%: Θ increases from 423° to 517°K and $\overline{u^2}$ falls from 2.65 to 1.92 × 10^{-18}. [English summary: PB 141126T-9, obtainable from Office of Techical Services, U.S. Dept. of Commerce, Washington, D.C., U.S.A.].

A.F.Brown

539.219

1939 HOMOGENIZATION OF ALLOYS OF THE INDIUM ARSENIDE–INDIUM SELENIDE SYSTEM BY ANNEALING UNDER PRESSURE.

N.A.Goryunova, S.I.Radautsan and V.I.Deryabina.
Fiz. tverdogo Tela, Vol. 1, No. 3, 512-14 (March, 1959). In Russian.

The results of X-ray analysis, metallographic examination and microhardness measurements of InAs–In_2Se_3 alloys containing 40-100% InAs and annealed for 68-270 hr at 600-700°C under pressures of 800-820 kg/cm^2 showed that this treatment is an effective means of homogenizing the microstructure of the studied alloys.

M.H.Sloboda

539.219

1940 CRYSTALLOGRAPHIC ORIENTATION OF NODULES FORMED BY THE GRAIN BOUNDARY REACTION OF ALUMINIUM–ZINC ALLOYS.

R.Watanabe and S.Koda.
Nature (London), Vol. 183, 1667-8 (June 13, 1959).

539.219 : 538.2

1941 THERMOMAGNETIC TREATMENT AND ORDERING PROCESSES. I. RELATION OF THE EFFECT OF THERMOMAGNETIC TREATMENT TO ORDERING PROCESSES.

Ya.S.Shur and A.A.Glazer.
Fiz. Metallov i Metallovedenie, Vol. 5, No. 2, 355-60 (1957).
In Russian.

Perminvar, 78- and 66-permalloy and permendur were studied.

539.23

1942 FORMATION, STRUCTURE AND DISINTEGRATION OF GOLD LEAF.

E.Brüche and K.J.Schulze.
Z. Phys., Vol.153, No.5, 571-91 (1959). In German.

Direct and dark-field electron microscopy and electron diffraction have been used to investigate the structure of commercial gold leaf, both in its original state and after etching and ultrasonic treatment. Comparison studies were made of "Zwischgold" (formed by beating a composite foil of gold and silver) and of gold precipitated from gold chloride. It was found that the beating process spreads out each crystallite over an area many thousand times greater than the initial size, the mechanism involving both fracture and movement on the slip planes. The final platelets are a few hundred Angstrom units thick and 0.1 to 1 μ in diameter; they are almost all oriented with the 100 plane parallel to the plane of the foil.

Local "families" of platelets retain almost identical orientation over regions as large as 10^{-2} mm, the variation in orientation being a few degrees, as seen from the diffraction pattern. It appears that gold layers only 100 A thick (about 25 unit cells) are stable at room temperature, which is roughly in accordance with the surface tension forces and the shear stress. The process of disintegration produces different results in gold leaf and in gold precipitates, the latter being single crystals. The results in general are compared with those of Hirsch, Kelly and Menter (Abstr. 2469/1956). V.E.Cosslett

539.23

1943 KINETICS OF CONDENSATION OF METALS IN VACUUM. L.S.Palatnik and Yu.F.Komnik.

Dokl. Akad. Nauk SSSR, Vol.126, No.1, 74-7 (May 1, 1959). In Russian.

Presents the results of an investigation of the initial stage of condensation of Bi, Pb, Sn and Sb on a "neutral" substrate (glass, collodion), using the methods of electrical resistance and of optical density; the surface of condensation is at a constant temperature or has a temperature gradient ($50\text{-}200^\circ$). In the initial period, the rate of condensation increases from zero to a certain constant value, viz. the higher the temperature of the substrate the slower the rate. Stabilization of the rate of condensation, as measured by the optical method, is reached much earlier than that indicated by the electrical method. The initial period is expressed by the formula $S = A_1(\nu\tau)^q$, where S is the optical density, A_1 - a constant depending on temperature, ν - the atomic "flux", and τ - the time of condensation. The experimental results are treated in accordance with the theory of two-dimensional state (Abstr. 2844 of 1924). See also Palatnik and Komnik (Abstr. 13826 of 1959) and Komnik, Palatnik and Fedorov [Izv. Akad. Nauk SSSR, Otdel. tekh. Nauk, No.11, 193(1957)]. F.Lachman

X-ray and Electron Microscope Examination

539.26

1944 X-RAY MICROSCOPY AND X-RAY MICROANALYSIS. V.E.Cosslett.

Nature (London), Vol. 184, 860-2 (Sept. 19, 1959).

This is a report of the second International Symposium on X-ray Microscopy and X-ray Microanalysis which was held in Stockholm in 1959. It was sponsored by the Department of Medical Physics, Karolsinska Institutet, Stockholm; the Department of Physics and Biophysics, Stanford University, California; and the Electron Microscopy Section of the Cavendish Laboratory, Cambridge.

539.27

1945 A SIMPLE METHOD OF EVALUATING ELECTRON MICROSCOPE STEREOPHOTOGRAPHS.

G.Pohlmann and M.Ahrend.

Optik, Vol. 16, No. 8, 461-71 (Aug., 1959). In German.

A method is described for obtaining quantitative information of the three-dimensional form of an object from stereophotographs taken in the electron microscope. They were made with the use of the stereostage in the Zeiss EM 8 electrostatic microscope. The photogrammetry was performed with the Zeiss "Stereopret", which produces a graphical representation of the specimen. The theoretical basis of the procedure is discussed in detail, with numerical examples; drawings made of a bacterium and a leaf surface are shown, with profile and contour lines. An object of $20\ \mu \times 20\ \mu$ in plan and $5\ \mu$ high can be reproduced to an accuracy of 1.3%, from a micrograph at 5000 × magnification. V.E.Cosslett

539.27 : 539.23

1946 GRAINLESS AND MAXIMUM RESOLUTION REGISTRATION OF ION AND ELECTRON IMAGES BY MEANS OF A LIGHT OPTICAL INTERFERENCE FILTER. R.Speidel.

Z. Phys., Vol. 154, No. 2, 238-63 (1959). In German.

Electron and ion images may be recorded in terms of the variation in thickness of the carbonaceous layer ("contamination") which is deposited on a substrate in proportion to the local current density. The layer is made visible by using it as the dielectric in an optical interference filter; by proper choice of the refractive index, the colour shift produced by the contamination layer can be maximized. The refractive index of such a layer was 2.35 when deposited in a vacuum of 5×10^{-4} mm Hg, produced by an oil diffusion pump without water-cooled baffle. The rate of growth of the layer was found from the colour shift, as measured with a spectrophotometer. The minimum detectable thickness was 3 A. In a lithium ion beam of 1.4×10^{-7} amp/cm^2, the rate of growth was 45 A/min on a substrate at -80° C; it fell to 1 A/min at room temperature and became zero at 110°C. At room temperature, on the average, 9 carbon atoms are deposited per incident ion. The rate of growth of the layer in a 40 kV electron beam was about 400 times smaller. Exposure time for a lithium ion image at 50 times magnification was about 30 min, but it could be reduced 10 times by subsequent evaporation of zinc on to the exposed surface. The intermediate image of an electrostatic electron microscope was recorded in this way with an exposure of 3 min at 50 times direct magnification. Optical enlargement by 600 times showed that the image was effectively grainless, the resolution in the layer being better than 0.5 μ. V.E.Cosslett

539.27 : 535.37 : 539.2

EXTENSION OF THE SCANNING MICROSCOPE TECHNIQUE TO THE OBSERVATION OF FLUORESCENT MATERIALS. See Abstr. 1763

539.27 : 541.18

1947 ELECTRON MICROSCOPY OF OLEOPHOBIC MONOLAYERS. R.T.Mathieson.

Nature (London), Vol. 183, 1803-4 (June 17, 1959).

This paper reports a study of oleophobic monolayers of stearic acid on mica by electron microscopy. Stearic acid was retracted from a solution in hexadecane; gold-palladium shadowing was employed. The results show that oleophobic surfaces are obtained even when only a third of the surface area is covered with stearic acid. An explanation of this is advanced in terms of hexadecane being incorporated in the monolayer but not in the replica of the surface. A.E.I. Research Laboratory

PHYSICAL CHEMISTRY

THERMOCHEMISTRY . REACTIONS

541.11

1948 HIGH FREQUENCY FACTORS IN UNIMOLECULAR REACTIONS. C.Steel.

J. chem. Phys., Vol.31, No.4, 899-900 (Oct., 1959).

The high frequency factors which are associated with certain unimolecular reactions are discussed in terms of an extended Kassel-type model, in which the critical energy is localized in more than one oscillator.

541.11

1949 FURTHER STUDIES OF THE PYROLYSIS OF DIMETHYL ETHER. S.W.Benson and D.V.S.Jain.

J. chem. Phys., Vol. 31, No. 4, 1008-17 (Oct., 1959).

For previous work, see Abstr. 7775 (1956). The pyrolysis of dimethyl ether was investigated over the pressure range 35 to 400 mm Hg and temperature range 750° to 820°K in a quartz flask. The results confirm the previous designation of an initial $\frac{3}{2}$ order rate relative to Me_2O but yield an activation energy of 55.6 kcal. This can be explained if it is assumed that CH_3OCH_2 is an important chain breaker and that the reaction $CH_3OCH_2 \rightarrow CH_3 + CH_2O$ is an energy transfer process in its second-order region. The small catalysis provided by added N_2 and CH_4 is supporting evidence for this. Further evidence comes from the observed rate of exchange of deuterium gas with Me_2O which is now in good accord with calculation. Values of the rate constants for CH_3 radical attack on H_2 and D_2 are in good agreement with those extrapolated from much lower temperatures. Some new values of rate constants are reported as well as new estimates of frequency factors and activation energies for various chain steps. There is some evidence for heterogeneous disappearance of H atoms at the wall, including a temporary inhibition observed in KCl-coated vessels. Small amounts of added O_2

have little effect on the rate while C_2H_4 is a very powerful inhibitor. At 780° K, chain lengths vary from 21 at 25 mm Hg to 84 at 400 mm Hg pressure. They decrease slowly with increasing temperature.

541.12

1950 INTERACTION OF OXYGEN WITH INCANDESCENT FILAMENTS.

J.R.Young.

J. appl. Phys., Vol. 30, No. 11, 1671-3 (Nov., 1959).

With the aid of a mass spectrometer a study has been made of the gaseous contaminants present when oxygen is exposed to different incandescent filaments. In agreement with others CO and CO_2 were the most abundant contaminants found. The amounts of CO and CO_2 found, at a given filament temperature and oxygen pressure, were greater for Mo 0.031% C, W 0.012% C, and Re 0.010% C than for Ta 0.001% C. Also at the same oxygen pressure and filament temperature the quantity of CO found was much greater for a carbonized W filament than for any of the other filaments investigated. These results are consistent with the hypothesis that CO and CO_2 are produced by the interaction of oxygen with the carbon present in the hot filaments. No evidence was found to indicate that the glass walls contribute to the formation of CO and CO_2.

541.12

1951 APPARENT ACTIVATION ENERGY AND FREQUENCY FACTOR FOR A PROCESS INVOLVING COMPETING MECHANISMS.

J.F.Nicholas.

J. chem. Phys., Vol. 31, No. 4, 922-5 (Oct., 1959).

If a process involves competing mechanisms, each of which individually obeys Arrhenius' equation, the dependence of the combined rate on temperature is in general not of this type. However, apparent activation energies and frequency factors are calculated in terms of the parameters of the distributions. The results for a two-peak distribution, a flat distribution, and a truncated exponential distribution are given analytically and graphically. A simple approximate method is described for determining the apparent activation energy in some cases. Some remarks are made about the "compensation effect."

541.12

1952 EQUILIBRIUM IN THE EXCHANGE OF HYDROGEN BETWEEN ARSINE AND WATER.

A.H.Zeltmann and G.Gerhold.

J. chem. Phys., Vol.31, No.4, 889-91 (Oct., 1959).

The equilibrium constant for the reaction

$$AsH_2D(g) + H_2O(l) \rightleftharpoons AsH_3(g) + HDO(l)$$

was measured at 25.4° and found to be 1.89 ± 0.02, corresponding to a value in the gas phase of 1.77 ± 0.02. With the known vibrational spectra of AsH_3 and AsH_3-d_3 the gas phase equilibrium constant was calculated at 25.4°, $K_2 = 0.777 \exp(258/T) = 1.84$.

541.12

1953 HYDROGEN ISOTOPE EFFECT IN THE OXIDATION OF BENZALDEHYDE-α-t WITH AQUEOUS ACID CHROMATE.

E.M.Hodnett.

J. chem. Phys., Vol. 31, No. 1, 275-6 (July, 1959).

The isotope effect in the oxidation of benzaldehyde-α-t, k_H/k_T, was found to be 7.9 ± 0.3; from the carbon-hydrogen and carbon—deuterium wavelengths found for benzaldehyde the carbon tritium wavelength is calculated as 5.76 μ (average value) and with 4.80 μ for the carbon—deuterium wavelength a value of 2.0 is found for k_D/k_T at 80° C, in fairly good agreement with the value of 2.37 ± 0.14 found from the above k_H/k_T ratio and the value of 3.34 ± 0.15 for k_H/k_T calculated for 80° C from the value of 4.3 ± 0.2 found by Wiberg at 25° C. R.C.Murray

541.12 : 548.5 : 539.2

GROWTH MECHANISM OF COPPER WHISKERS BY HYDROGEN REDUCTION OF CUPROUS IODIDE.

See Abstr. 1888

541.12

1954 THEORETICAL TREATMENT OF THE INFLUENCE OF STERIC EFFECTS ON THE REACTIVITY OF ALIPHATIC COMPOUNDS. I.

F.Becker.

Z. Naturforsch., Vol. 14a, No. 5-6, 547-56 (May-June, 1959). In German.

Ivanoff and Magat [J. Chim. phys., Vol. 47, 914 (1950)], and Bauer and Magat (ibid 922), have described a method of assessing theoretically steric entropy effects on the reactivity of paraffins. Pitter [J. chem. Phys., Vol. 8, 711 (1940)] and [Chemical Review, Vol. 27, 39 (1940)] has given a steric distribution function. The combination of these two treatments makes it possible to assess two kinds of steric influences almost quantitatively: (1) the space requirements of the reaction partners reduce the internal mobility and thus reduce the Arrhenius equation, and (2) the increase of the intramolecular repulsive forces during the formation of transition states in bimolecular reactions increases their activation energy. Simple and branched paraffins are treated and some of the parameters computed. M.Ebert

541.12

1955 THE THERMODYNAMIC PROPERTIES OF THE OXIDES OF TUNGSTEN.

J.I.Guérassimov and I.A.Vassiliéva.

J. Chim. phys., Vol. 56, No. 7, 636-40 (July, 1959). In French.

The reduction by hydrogen of the two forms, α and β, of WO_3, stable at room and high temperature respectively, in the range 600°-900° C has been studied by determining the equilibrium constants between the gaseous phase and the solid. The nature of the intermediate reduction products were studied by X-ray methods. It is concluded that the reduction of both forms occurs in four stages but the intermediate products have different forms although the same gross composition. The more or less abrupt changes in the reaction constants occur at $WO_{2.90}$, $WO_{2.72}$ and WO_2, i.e. at the values for the oxides studied by Magneli et al. It is suggested that another oxide may exist between WO_3 and $WO_{2.90}$. No suboxide W_3O was found in the reduction of WO_2. The heat of formation of WO_3 is calculated and compared with the values obtained by other workers. F.E.Hoare

541.12

1956 THE THERMODYNAMIC PROPERTIES OF SOME LIQUID METALLIC ALLOYS.

J.I.Guérassimov, A.V.Nikolskaia and A.M.Evséev.

J. Chim. phys., Vol. 56, No. 7, 641-8 (July, 1959). In French.

Measurements of the electromotive force in cells of which a molten alloy forms one limb have been used to obtain the activities of metals in alloy systems. Alternatively the vapour pressure has been obtained by the Knudsen effusion method. From such measurements the thermodynamic properties of the constituent metals may be obtained. Results are presented for the Cd-Bi, Pb-Sn, Cu-Bi, Cu-Sb and Cd-Cu systems. These are discussed in relation to the occurrence of local order in the alloys and comparison made with a theoretical expression for the heat of solution of Cd in the Cd-Bi system. F.E.Hoare

541.12 : 534.22

INVESTIGATION OF THE TRAIL IN SPINNING DETONATIONS.

See Abstr. 994

541.12 : 534.22

1957 CALCULATION OF REACTION PROFILES BEHIND STEADY STATE SHOCK WAVES. II. THE DISSOCIATION OF AIR.

R.E.Duff and N.Davidson.

J. chem. Phys., Vol. 31, No. 4, 1018-27 (Oct., 1959).

For Pt I, see Abstr. 6474 (1958). A numerical integration procedure was used to investigate the reaction profile behind strong shock waves in air. The Mach number range from 8 to 15 was covered; the initial temperature was 300° K and the initial pressures were 1 to 10 mm Hg. The dissociation reactions for O_2, N_2, and NO were considered along with the "shuffle" reactions $N + O_2 \rightleftharpoons NO + O$ and $O + N_2 \rightleftharpoons NO + N$. No ionization reactions were included. Above $M_S = 10$, the calculations show a pronounced transient maximum in the NO concentration. In addition, the rate of change of concentrations at constant volume of all species except O_2 change sign under certain conditions. Several additional calculations were made which included an approximate treatment of the effects of a finite rate of vibrational excitation of O_2 and N_2. These calculations suggest that even at $M_S = 15$, the vibrational excitation reactions have only a limited effect on the reaction profile. A calculation of the reaction profile for air at high pressure diluted with a large excess of inert gas at 3000° K showed that the Zeldovich mechanism approximately describes the production of NO under these conditions even though it fails completely for undiluted air at high temperatures.

541.12 : 621.762

1958 SINTERING REACTIONS OF ZINC OXIDE.

V.J.Lee and G.Parravano.

J. appl. Phys., Vol. 30, No. 11, 1735-40 (Nov., 1959).

The sintering of zinc oxide spheres has been studied in the temperature range from 700° to 900°C in air, oxygen, helium, and hydrogen. Fresh zinc oxide sinters rapidly in air and oxygen, but it does not sinter appreciably in helium in the same temperature range. Zinc oxide spheres annealed separately in air may not be sintered in air at temperatures as high as 1100°C. On the other end, fresh spheres, separately air annealed and subsequently treated in an hydrogen atmosphere, do sinter in the temperature range from 700° to 900°C. These facts are explained on the basis of a mechanism involving the diffusional transfer of stoichiometric excess of zinc ions. The diffusion equation for zinc ions is derived, and the experimental points fit the equation satisfactorily. The treatment shows that the relationship between the width of bridges connecting sintering spheres and time varies with extent of sintering. This fact invalidates the use of this relationship as a unequivocal diagnostic criterium for the sintering mechanism in nonstoichiometric oxides.

ELECTROCHEMISTRY

541.13

1959 THE ISOTOPIC EFFECT OF LITHIUM IONS IN COUNTERCURRENT ELECTROMIGRATION IN MOLTEN LITHIUM BROMIDE AND IODIDE.

A.Lundén, S.Christofferson and A.Lodding.
Chalmers Tekn. Högsk. Handl., No. 221, 38 pp. (1959).

The isotopic effect of electromigration has been studied for lithium ions in the following chains of molten salts:

cathode + $Br_2/LiBr/PbBr_2/Br_2$ anode
cathode $Pb/PbBr_2 \vdots LiBr/PbBr_2/Br_2$ anode
cathode $Pb/PbI_2 \vdots LiI/PbI_2/I_2$ anode

(The dotted line indicates a diffuse boundary). Altogether six bromide and three iodide runs were performed. The heavy isotope Li^7 was enriched in a separation column at the boundary between the lithium and lead halides. The maximal enrichment obtained corresponded to a separation factor of 970. The mass effect (relative difference in mobility for ions of the two isotopes, divided by their relative difference in mass) for Li was was found to be −0.148 ± ± 0.014 in LiBr and −0.15 ± 0.02 in LiI. A previously reported value for the mass effect in LiBr (Abstr. 640 of 1957) has thus been corrected.

541.13

1960 ANALOGUE SOLUTION OF THE PROBLEM OF CATHODE POLARIZATION.

R.H.Rousselot.
J. Rech. Cent. Nat. Rech. Sci., No. 47, 141-5 (June, 1959).
In French.

The current distribution in an electrolytic cell, existing immediately after voltage is applied to the electrodes, changes rapidly due to polarization, passing through several stages as metallic deposition commences. It is shown that these stages can be simulated by means of conducting paper model, and the final current distribution deduced. A.E.I. Research Laboratory

PHOTOCHEMISTRY
RADIATION CHEMISTRY

541.14

1961 ACTINOMETRIC DETERMINATION OF THE DISSOCIATION OF CARBON DIOXIDE BY A SINGLE FLASH.

M.H.Bortner, V.D.Povard and A.L.Myerson.
J. Opt. Soc. Amer., Vol. 50, No. 2, 172-3 (Feb., 1960).

Significant amounts of carbon dioxide have been dissociated by a single flash of a xenon-filled quartz flash tube. For any one piece of quartz, the effectiveness of a discharge varied as expected with the various parameters. Considerable variation was found between any two pieces of quartz. The maximum output encountered was equivalent in the spectral region used to a blackbody of about 8000°K.

541.14

1962 INITIATION OF THERMAL REACTIONS BY THE FLASH ILLUMINATION OF ABSORBING BODIES.

J.L.Lundberg and L.S.Nelson.
Nature (London), Vol. 183, 1560-2 (June 6, 1959).

The authors have made a qualitative study of the effects which arise when small absorbing bodies are subjected to flash illumination (~ 5000 joules, 4000 V, 2.5 msec). For small particles in vacuo, the surface temperature increases with decrease in particle size until black-body conditions are reached — in these experiments giving temperatures of about 4100° C for bodies of radius less than 1 μ. When spherical absorbing particles are dispersed in condensed transparent media, loss of heat by conduction is important, and there is an optimum size for maximum temperature, but for plate-shaped particles or foils, surface temperatures are similar to those obtaining in vacuo. With this technique, metals and carbon have been evaporated, hydrocarbons pyrolysed and polymers degraded. The process is essentially heterogeneous sensitization, in which optical energy is transformed via thermal excitation into chemical energy. R.F.Barrow

541.15

1963 ACTIVITY CONCEPT IN RADIATION CHEMISTRY.

H.A.Mahlman.
J. chem. Phys., Vol. 31, No. 4, 993-5 (Oct., 1959).

The decomposition of aqueous solutions by ionizing radiations is interpreted by assuming an initial solvent decomposition into H atoms and OH radicals. Radical recombination gives rise to the observed molecular products H_2 and H_2O_2. Substantiating this hypothesis, it is demonstrated that reaction of solutes with the radicals depress the yields of the molecular products. The linear dependence of the molecular yields on the cube root of the solute molarity applies very well for dilute solutions of strong electrolytes, i.e., where the molarity and the activity are essentially equal; however, in more concentrated solutions considerable deviation is observed. It is in this region that the activity of an electrolyte manifests itself, and therefore the cube root of the activity is the criterion rather than the molarity. Particular study was made of the depression of hydrogen yields by aqueous sodium nitrate solutions. Alteration of the molecular hydrogen yield was demonstrated by varying the scavenging solute concentration and the activity of the scavenging solute. The addition of three different salts representing uni-univalent, di-univalent, and tri-univalent electrolytes was used to alter the ionic strength of the solutions.

541.15

1964 THE SYNTHESIS OF CERTAIN ORGANIC COMPOUNDS IN AN ULTRASONIC WAVE FIELD

A.V.Sokol'skaya and I.E.Él'piner.
Akust. Zh., Vol. 4, No. 3, 288-9 (1958). In Russian.

Continuation of work reported earlier (Abstr. 5507 of 1958). Starting with methylene chloride (CH_2Cl_2) it is shown that under cavitation conditions a compound of empirical formula $C_{10}H_7O_3Cl_2$ is formed as indicated by a spectrophotometer. [English translation in: Soviet Physics—Acoustics (New York), Vol. 4, No. 3, 297-8 (July-Sept., 1958)]. C.R.S.Manders

541.15

1965 THE DEHYDRATION OF GYPSUM IN AN ULTRASONIC FIELD.

V.A.Zolotov and A.I.Kurochkin.
Dokl. Akad. Nauk SSSR, Vol. 127, No. 5, 1009-10 (Aug. 11, 1959).
In Russian.

A weak ultrasonic field was found to accelerate the formation of the β-anhydrite but have little effect on the formation of the α-anhydrite. J.Jarzynski

541.15

1966 KINETICS OF THE DECOLORIZATION OF CONGO RED UNDER ULTRASONIC RADIATION.

Satya Prakash and Sheo Prakash.
J. Acoust. Soc. Amer., Vol.32, No.1, 138-9 (Jan., 1960).

The fading of the colour of the congo red dyestuff at concentrations 0.016, 0.01, and 0.0005 g/l. under the influence of ultrasonic radiation from a Mullard generator with barium titanate crystal having a frequency of 1 Mc/s and power output 225 W has been studied and the reaction is found to be unimolecular, the average velocity constants being respectively, 0.129, 0.209, and 0.193. The fading of congo red is not due to the production of hydrogen peroxide, and it is neither an oxidation nor a reduction process in the ordinary sense. The high cavitation energy appears to be responsible for the breaking down of the molecule of congo red resulting in the colour fading.

DISPERSIONS . COLLOIDS ADSORPTION

541.18

1967 WEAKENING OF INFRA-RED RADIATION BY WATER VAPOUR. E.I.Bocharov.

Izv. Akad. Nauk SSSR, Ser. geofiz., 1958, No. 6, 791-5. In Russian. English summary. PB 141042T-2, obtainable from Office of Technical Services, U.S. Dept. of Commerce, Washington, D.C., U.S.A.

Attenuation of infrared radiation at 13 wavelengths between 2 and 13 μ by water vapour mists was measured and correlated with measured particle size distribution of droplets in the mists.

R.W.Nicholls

541.18

1968 MOLECULAR DISSOCIATION AND RECONSTITUTION ON SOLIDS. G.Ehrlich.

J. chem. Phys., Vol. 31, No. 4, 1111-26 (Oct., 1959).

The dependence of heterogeneous reactions on the nature of the solid surface is explored by analysing the elementary rate processes involved. The relations between the rates of adsorption, surface diffusion, and evaporation, and the depths and distribution of binding sites on the surface are presented. Empirical generalizations concerning the binding energy of adatoms and the cohesive energy of solids are examined; Pauling's additivity rule is found to fail for most metal hydrides and thus does not provide a reliable base for estimating the covalent contribution to the heat of adsorption. Rates of association of atoms and dissociation of molecules on solids are estimated from a knowledge of the experimental heat of adsorption $-\Delta H$ and the postulate that the activated complex for dissociative chemisorption of a diatom has a configuration resembling two noninteracting atoms, one in its equilibrium binding position on the surface, the other in the saddle-point position for surface migration. For chemisorption on clean metals, it is found that an activation energy can be expected only for systems in which the heat of adsorption is small ($-\Delta H < 10$ kcal/mole), in agreement with experiment. Conversely, desorption of diatoms by combination of atoms deposited in excess of the equilibrium amounts on metals on which $-\Delta H < 0$ is limited only by surface diffusion and therefore should occur rapidly, as is observed. The mechanism of heterogeneous recombination of atoms is outlined; it is shown that for hydrogen atoms only small variations in the efficiency of this process on different metals are expected at pressures of the monatomic gas less than 10^{-3} mm, and that these are primarily dictated by the rate of direct recombination between gas phase and adsorbed atoms. For metals on which chemisorption from the molecular gas is endothermic, the recombination coefficient should approach unity above room temperature. In the converse process, the dissociation of diatomic molecules into atoms at a hot metal surface, variations in the rate of atomization may occur for different metals; for those on which adsorption is endothermic the rate should be small since it is the adsorption step which results in specificity. The rate of atomization is also shown to depend upon the first power of the pressure of the molecule gas p_2 in the region of low pressures, changing to a dependence on $p_2^{1/2}$ at higher pressures where encounters between adsorbed atoms become limiting. The same picture of the activated complex for chemisorption is applied to the interaction of gases with nonmetals. From the appreciable activation energy observed for adsorption of diatoms on nonmetals, it is concluded that binding sites on these surfaces are widely separated. This suggests that dissociation or excitation of the gas-phase molecule to a higher vibrational state should increase the rate of adsorption, and conversely that the recombination efficiency of nonmetals for atoms should be small. These expectations are found to be in agreement with experiment.

541.18: 537.311 : 539.2

ELECTRONIC THEORY OF CHEMISORPTION ON THE REAL SURFACE OF A SEMICONDUCTOR. See Abstr. 1634

541.18 : 539.27

ELECTRON MICROSCOPY OF OLEOPHOBIC MONOLAYERS. See Abstr. 1947

541.18 : 533.5

1969 INTERACTION OF ATOMIC HYDROGEN WITH GLASS. T.W.Hickmott.

J. appl. Phys., Vol. 31, No. 1, 128-36 (Jan., 1960).

An omegatron ion resonance mass spectrometer has been used to study residual gases in an ultra-high vacuum system. Atomic hydrogen, produced from molecular hydrogen by an incandescent tungsten filament, reacts with glass to produce contaminant molecules, CO, H_2O, and CH_4, whose presence seriously interferes with studies of surface phenomena. Such spurious effects are substantially reduced by substituting a lanthanum boride-coated tantalum filament for the tungsten electron source of an ionization gauge used to measure pressures of hydrogen. Quantitative measurements of the binding atomic hydrogen by glass show the existence of two distinct binding sites of nearly equal population that are occupied simultaneously at low surface coverages and low temperatures. The rate of recombination of atomic hydrogen bound to glass is proportional to the number adsorbed and is much smaller than the rate of recombination of atomic hydrogen impinging on a glass surface from the vapour phase.

PHYSICAL METHODS OF CHEMICAL ANALYSIS

545.8

1970 ON THE EXISTENCE OF THE OXIDATION PRODUCTS Si_2O, SiO, AND Si_2O_3 OF SILICON.

A.Faessler and H.Krämer.

Ann. Phys. (Leipzig), Folge 7, Vol. 4, No. 1-5, 263-8 (1959). In German.

The compound SiOR = $Si_2O{\cdot}R_2O$ with R = C_2H_5 has been prepared and its X-ray emission spectrum has been examined. The K_α-doublet of this "Si_2O" material is shifted towards shorter wavelengths than that of Si by 0.44 eV. The K_α-doublet of synthesized materials whose silicon-to-oxygen ratio corresponded to Si_2O_3 is shifted still further towards the ultraviolet by 0.55 eV. It is likely that the technical SiO is a mixture of Si with its different oxides.

R.Schnurmann

545.8 : 535.33

1971 USE OF A HOLLOW-CATHODE DISCHARGE FOR DETERMINATION OF IMPURITIES IN ZrO_2. I.

Yu.I.Korovin and L.V.Lipis.

Optika i Spektrosk., Vol. 5, No. 3, 334-7 (Sept., 1958). In Russian. English summary: PB 141047T-7, obtainable from Office of Technical Services, U.S. Dept. of Commerce, Washington, D.C., U.S.A.

A quartz water-cooled discharge tube was used at 1 kV with He as carrier gas and graphite electrodes. Optimum currents and sample weights are given for detection of different impurities and the best spectral lines for use with 24 different elements are given with limiting sensitivities (of order 10^{-3} to 10^{-5}%). 20 to 25 samples can be analysed in a day.

W.T.Welford

GEOPHYSICS

550.3

1972 ON THE DISTRIBUTION OF RESIDUAL MAGNETIZATION IN CUBES AND CYLINDERS FROM ROCKS.
A.G.Kalashnikov.
Izv. Akad. Nauk SSSR, Ser. geofiz., 1958, No. 4, 550-3. In Russian.
English summary: PB 141042T-5, obtainable from Office of Technical Services, U.S. Dept. of Commerce, Washington, D.C., U.S.A.

It is shown that in specimens from the outer regions of large rocks of high magnetic susceptibility, the distribution of the direction of magnetization can be quite complex, and as a rule the magnetization is not in the direction of the magnetizing field.

S.J.St-Lorant

550.3 : 538.1

ON THE ANALYTIC CONTINUATION OF TWO-DIMENSIONAL MAGNETIC FIELDS. See Abstr. 1180

550.34 : 534.2

SEISMIC WAVES IN INHOMOGENEOUS ELASTIC MEDIA. See Abstr. 987

550.3

1973 NORMAL MAGNETIZATION AND THERMOMAGNETIZATION OF ANISOTROPIC ROCKS.
M.A.Grabovskii and S.Yu.Brodskaya.
Izv. Akad. Nauk SSSR, Ser. geofiz., 1958, No. 8, 977-88. In Russian.
English summary: PB 141042T-6, obtainable from Office of Technical Services, U.S. Dept. of Commerce, Washington, D.C., U.S.A.

Magnetically isotropic specimens of thinly-layered iron-mica magnetite quartz from the Kursk magnetic anomaly are studied under conditions of normal and thermomagnetization. It is concluded that the total magnetization of the rock will be generally in a direction oblique to its layer structure; the magnetic stability of such a rock is described in terms of multi-parameter relations, each of which is linked to the geological conditions of formation of the residual magnetization.

S.J.St-Lorant

550.9 : 539.16

RADIOACTIVE DATING: HALF-LIFE AND BETA SPECTRUM OF Rb^{87}. See Abstr. 1387

550.8

1974 THE EFFECT OF A NON-HOMOGENEOUS EARTH ON THE FIELD OF A STRAIGHT INFINITELY LONG CABLE. V.I.Dmitriev.
Izv. Akad. Nauk SSSR, Ser. geofiz., 1959, No. 4, 621-3. In Russian.

Refers to the cable method used in geophysical prospecting. The infinite cable is assumed to be at the horizontal boundary between the air and a homogeneous resistive earth containing an infinitely thin perfectly conducting vertical vein with its top end a distance l below the cable. The working shows that with l small compared with the wavelength in earth λ, the anomalous field modulus and phase are of the order 10-50% and 10-50° respectively. The anomalous field is damped rapidly as l increases. The average anomaly width is 0.1-0.2 λ and increases as l increases.

D.E.Brown

551.4

1975 SOME PHYSICAL PROPERTIES OF SEA ICE. II.
M.P.Langleben.
Canad. J. Phys., Vol. 37, No. 12, 1438-54 (Dec., 1959).

For Pt I, see Abstr. 9059 of 1959. Some properties of annual sea ice at mid-temperature latitudes are investigated. It is found that the salinity is comparable to, and the density much lower than, annual arctic sea ice. Permeability to air flow compares favourably to calculations based on the model of sea ice of Anderson and Weeks (1958). Small sample ring tests of ultimate tensile strength yield values ranging from 9.5 to 24.8 kg cm^{-2} at test temperatures of −3.6 to −17.2° C. Tensile strength appears to depend on crystal size rather than on brine content.

ATMOSPHERE . IONOSPHERE

(Abstracts on radiowave propagation in ionized media will also be found under Electromagnetic Waves)

551.5

1976 HIGH-ALTITUDE OBSERVATION TECHNIQUES.
R.C.Staley.
Science, Vol. 130, 845-8 (Oct. 2, 1959).

A review of methods available for the study of upper atmosphere physics.

551.5

1977 AIR DENSITY IN THE UPPER ATMOSPHERE FROM SATELLITE ORBIT OBSERVATIONS. G.V.Groves.
Nature (London), Vol. 184, 178-9 (July 18, 1959).

Data on six different satellites have been used to estimate the variation of air density with height over the range 150 km to 700 km. Some further observations suggest that it may be necessary to increase the quoted values when the local time lies in the range 12.00 to 18.30 hr. The results refer mainly to perigee latitudes between 36°N and 33°S. Comparison with rocket firings indicates a considerable latitude effect and suggests a need for satellites with orbital inclinations near 90°.

C.Hazard

551.5

1978 A METHOD FOR OBTAINING THE ATMOSPHERIC TEMPERATURE AND WIND [VELOCITY] FROM SOUND PROPAGATION IN THE ROCKET SOUNDING.
Y.Takeya and T.Okumoto.
J. Geomagn. Geoelect., Vol. 10, No. 3, 118-25 (1959).

An attempt is made to determine the atmospheric temperature and wind velocity at high altitude from sound propagation. The space to be measured is divided into several layers, in each of which the temperature and wind distributions are assumed to take the form of a second order equation in height. In this assumption the formulae to deduce the temperature and the wind are given by use of Snell's law for sound propagation under the existence of wind. As the results involve hyperelliptic integrals, it is difficult to derive explicitly the distributions of temperature and wind velocity, but it is possible to find the values required by numerical calculus of the integrals. It is shown that the results are determined uniquely in general, and a simple case is given to explain the use of the theory in practice.

551.5

1979 DETECTION OF ~ 10 keV ELECTRONS IN THE UPPER ATMOSPHERE BY MEANS OF SPUTNIK 3.
V.I.Krasovskii, I.S.Shklovskii, Yu.I.Gal'perin and E.M.Svetlitskii.
Dokl. Akad. Nauk SSSR, Vol. 127, No. 1, 78-81 (July 1, 1959).
In Russian.

Detectors used (fluorescent, Ag-activated ZnS screens with 2 mg of substance per cm^2) recorded only electrons with energies of the order of 10 keV, and practically no X-rays, while any protons with similar energy were retained by Al foil; the use of this foil enabled the "equivalent" energy of electrons to be estimated. Electrons with energy of ~ 10 keV were recorded at heights of 470-1880 km above sea level; for an "equivalent" energy of 20 keV the minimum flux is estimated to be 10^{-14} A cm^{-2} sterad $^{-1}$ above the geomagnetic equator, while at medium and polar geomagnetic latitudes (up to 60°) the corresponding figures are 12 keV and between 5×10^{-11} and 10^{-10} A cm^{-2} sterad $^{-1}$.

F.Lachman

551.5

1980 STRATOSPHERIC CARBON-14, CARBON DIOXIDE, AND TRITIUM.
F.Hagemann, J.Gray, Jr, L.Machta and A.Turkevich.
Science, Vol. 130, 542-52 (Sept. 4, 1959).

Reports the results of measurements made in recent years. The purpose was to obtain information on the concentrations produced by the explosion of nuclear devices and to study the changes in these concentrations with time. Such data can be expected to furnish new insight into the circulation of the stratosphere, as well as to contribute to the evaluation of the hazards from nuclear explosions in the atmosphere.

551.5

1981 THE ACCELERATION OF PARTICLES IN THE OUTER ATMOSPHERE. T.Obayashi.

J. Geomagn. Geoelect., Vol. 10, No. 4, 151-2 (1959).

The successful launching of Pioneer III and IV, brought new evidence to indicate the existence of regions trapping high energy particles in the earth's outer atmosphere (J.A.Van Allen and L.A.Frank, Nature, Vol. 183, 430-4, 1959). There are two distinct zones of intense flux of energetic particles of the order of million electron volts, the inner zone situated a few thousand kilometers above the earth's surface, the outer zone at a distance of 3 ~ 4 earth radii. This paper suggests a possible mechanism producing such high energy particles in the outer atmosphere, it being considered that the energetic particles are produced in the earth's outer atmosphere rather than being injected from the outside and trapped by the geomagnetic field.

551.5

1982 HYDROMAGNETICS IN THE EARTH'S OUTER ATMOSPHERE. T.Tamao.

J. Geomagn. Geoelect., Vol. 10, No. 4, 143-50 (1959).

Studies of the hydromagnetic interactions of the ionic exosphere with the geomagnetic field are reviewed. Considering the various hydromagnetic interactions, it is shown that the geomagnetic dipole field and the earth's atmosphere are confined within a cavity of radius of about six to ten earth radii, and hydromagnetics in the outer atmosphere are reduced to the electrodynamics for the thin transition layer between the interplanetary gas and the earth's exosphere.

551.5

1983 IONIZATIONS IN THE OUTER ATMOSPHERE INFERRED FROM WHISTLING ATMOSPHERICS. J.Outsu and A.Iwai.

J. Geomagn. Geoelect., Vol. 10, No. 4, 135-42 (1959).

From dispersions of whistling atmospherics, ionization densities in the outer atmosphere are roughly estimated, and diurnal variations of electron density in the lower parts of the atmosphere are obtained. In order to examine the origin of the ionization, the kp index is compared with the rate of occurrence of whistlers, but no correlation is obtained, even when altered slightly positive by using the value of kp taken two days in advance. Observations at low latitudes show that an ionized hydrogen atmosphere is likely in the exosphere.

551.5

1984 RADIATION AND LAG ERRORS OF THE F-TYPE RADIOSONDE.

A.Mani, C.N.Venkataraman and B.B.Huddar.

Indian J. Meteorol. Geophys., Vol. 10, No. 2, 189-98 (April, 1959).

The calibration of the Indian radiosonde for radiation errors is described. J.M.Hough

551.5

1985 INVESTIGATION OF MAGNETO-IONIC FADING IN OBLIQUE INCIDENCE MEDIUM-WAVE TRANSMISSIONS. M.Srirama Rao and B.Ramachandra Rao.

J. atmos. terrest. Phys., Vol. 12, No. 4, 293-305 (1958).

Periodic fading of magneto-ionic origin observed in oblique incidence medium-wave records is interpreted theoretically by calculating the phase paths by a graphical integration method assuming Chapman and parabolic ion distribution. Analytical expressions have also been derived for phase paths of both magneto-ionic components by an approximate method involving the use of an empirical formula for q-x curves. The theoretical values of fading periods compared very well with the experimental data, the agreement being particularly good for the case of Chapman distribution.

551.5

1986 WAVEFORMS OF ATMOSPHERICS WITH SUPERIMPOSED PULSES RECORDED WITH AN AUTOMATIC ATMOSPHERICS RECORDER. B.A.P. Tantry and R.S.Srivastava.

J.atmos.terrest. Phys., Vol.13, No.1-2, 38-42 (1958).

The automatic atmospheric recorder constructed and used by the authors has been briefly described. Of the various types of superimposed pulses recorded, the "stepped" pulses from a lightning source, superimposed on the waveform due to a different lightning discharge has not been observed by previous investigators. Superimposed pulses, reflected successively from the ionosphere have been shown, where the superimposed pulses and the waveform on which they are superimposed originate from two different lightning sources or from the same lightning discharge. The "hook"—components of Malan and Schonland have also been recorded.

551.5

1987 SIMULTANEOUS RECORDING OF ATMOSPHERICS ON FOUR DIFFERENT FREQUENCY BANDS IN THE LOW-FREQUENCY REGION. M.W.Chiplonkar and V.N.Athavale.

J.atmos. terrest. Phys., Vol.13, No.1-2, 32-7 (1958).

To study variations in the intensity and numbers of atmospherics received in the low-frequency region, four narrow band t.r.f. receivers were designed and constructed. The bands are 85 kc/s, 125 kc/s, 175 kc/s and 455 kc/s respectively. The output of the receivers were given to the X-deflecting plates of four identical cathode ray tubes. A moving plate camera with an f/2.5 coated lens recorded simultaneously the deflections of all the c.r.t. spots. Records of 1 min duration were taken at two fixed hours (2000 and 2200 hours) during the night. Over seventy plates were obtained during the period March-June 1956, and measured to give intensities and number of atmospherics on the four bands. It was found that : (a) atmospherics with relatively large field strengths were less frequent than those with smaller field strengths on each band; (b) the field strength of atmospherics received on 125 kc/s band had maximum values as compared with those on the other bands and was the seat of maximum activity of atmospherics with both large field strengths and number.

551.5

1988 THE RELATIONSHIP BETWEEN ATMOSPHERIC RADIO NOISE AND LIGHTNING. F.Horner.

J. atmos. terrest. Phys., Vol. 13, No. 1-2, 140-54 (1958).

Examination of atmospherics in a bandwidth of 300 c/s at 10 kc/s from storms of known location in Europe has shown that in median amplitude, amplitude range and frequency of occurrence, they corresponded with what would be expected from lightning discharges to ground. Other experiments in Australia showed that atmospherics from tropical storms had overall durations similar to those of lightning discharges, and consisted of a series of pulses. High frequency atmospherics had similar durations to those recorded at very low frequencies, but were more continuous. The start and finish of h.f. atmospherics tended to coincide with large v.l.f. pulses. The atmospherics were much longer than would have been expected if stepped leader discharges had been the main source.

551.5

1989 SOLAR PROTONS AS THE CAUSE OF THE MORNING AND NOCTURNAL MAGNETIC DISTURBANCES AT HIGH LATITUDES. A.P.Nikol'skii.

Dokl. Akad. Nauk SSSR, Vol.127, No.1, 82-5 (July 1, 1959). In Russian.

On the basis of Störmer's theory (Abstr. 3395 of 1956), the author explains the appearance of the morning and nocturnal disturbances, for example the nightly maximum is ascribed to the B and C zones of Störmer. See also Nikol'skii [Dokl. Akad. Nauk SSSR, Vol.109, No.5, 939 (Aug. 11, 1956)]. F.Lachman

551.5

1990 CONCERNING THE APPLICATION OF THE REAL MAGNETIC FIELD AT ALTITUDE TO THE STUDY OF MAGNETIC PHENOMENA. P.N.Mayaud.

J. geophys. Res., Vol. 63, No. 4, 870-2 (Dec., 1958). In French.

Results on the variation of the horizontal field are presented in an attempt to demonstrate the systematic use of the real field in connection with investigations into the magnetic variations on the earth's surface due to external phenomena. If the hypothesis that the electrojet follows the magnetic equator is accepted, then it should be possible to determine the height of the electrojet from measurements made at the magnetic meridian. S.J.St-Lorant

551.5

1991 THE FINE STRUCTURE OF THE GEOMAGNETIC SOLAR ECLIPSE EFFECT. H.Volland.

J. atmos. terrest. Phys., Vol. 11, No. 1, 1-13 (1957). In German.

The extension of the theory of the solar eclipse effect in the geomagnetic field by the introduction of empirical functions and the detailed discussion of the induction in the earth's interior and other influences makes possible a quantitative interpretation of the effect. The dependence of the shadow centre with the height is opportune for the decision in what height the S_q-current flows. A method to determine the direction of the S_q-current during an eclipse is mentioned.

551.5

1992 MORPHOLOGY OF SSC AND SSC*.

S.Abe.

J. Geomagn. Geoelect., Vol. 10, No. 4, 153-63 (1959).

In general it is very rare that SSC* is not observed in any part of the world at the time of sudden commencement of magnetic storms. The electric current-systems for the world distribution of the preliminary impulse and the main impulse of the sudden commencement vectors are derived. These current-systems will be situated in the earth's upper atmosphere except for the current representing the world-wide increase in the horizontal component of geomagnetic field of extra-terrestrial origin. The dependency of occurrence frequency of SSC* on local time and latitude can reasonably be explained by the characteristic modes in these current-systems. A theoretical interpretation of SSC and SSC* phenomena is possible by combining the merits of various different theories.

551.5

1993 SOME CHARACTERS OF GEOMAGNETIC PULSATION PT AND ACCOMPANIED OSCILLATION SPT.

K.Yanagihara.

J. Geomagn. Geoelect., Vol. 10, No. 4, 172-6 (1959).

A study of the characteristics, occurrence frequency, and accompanying short period oscillations (spt) of the group of night pulsations (pt) examined by Angenheister, Scholte, Veldkamp and Yanagihara. The observed reverse proportionality [K.Yanagihara, Memo Kakioka Mag. Obs, 8., 49 and 69 (1957)] of the (pt) 11-year cycle of activity to that of solar activity is explained in terms of the transmission and nontransmission of hydromagnetic oscillations in the earth's outer atmosphere through the exosphere to the ground, depending on the ion density of the reflecting zone, itself dependent on the sunspot activity.

551.5

1994 MORPHOLOGY OF THE GEOMAGNETIC PULSATION.

T.Watanabe.

J. Geomagn. Geoelect., Vol. 10, No. 4, 177-84 (1959).

A descriptive and statistical study of the occurrence of the geomagnetic pulsations (pt) and (pc) in middle latitudes; also a separate review of giant pulsations (pg), and rapid pulsations or vibrations.

551.5

1995 PARTICLES OF AURORAE AND GEOMAGNETIC PULSATIONS.

Y.Kato and T.Watanabe.

J. Geomagn. Geoelect., Vol. 10, No. 4, 185-94 (1959).

It is shown that the geomagnetic pulsation is caused by hydromagnetic oscillation of the exosphere excited by solar charged corpuscles impinging on the earth as predicted by Störmer. Pc-type pulsations are excited by auroral particles impinging on the 09 h impact-zone, of which latitude is higher than the usual auroral zone and which gives rise to a second auroral zone as suggested by Nikolsky. Pt-type pulsations are excited by particles impinging on the 1 h zone, corresponding to the usual auroral zone. The L.M.T. dependence of the occurrence-frequency of geomagnetic pulsations is well explained, assuming that the intensity of geomagnetic pulsations at a station will be lesser as it is more distant from the impact-zone. On the other hand, the G.M.T. control in the occurrence-frequency, as suggested by Troitskaya, is to be expected due to an inclination of the geomagnetic axis to the rotation of the earth.

551.5

1996 HYDROMAGNETIC OSCILLATION OF THE OUTER IONOSPHERE AND GEOMAGNETIC PULSATION.

T.Watanabe.

J. Geomagn. Geoelect., Vol. 10, No. 4, 195-202 (1959).

A suggestion is given that resonance is possible to occur in the hydromagnetic oscillation of the lower part of the exosphere to give rise to the geomagnetic pulsation. The hydromagnetic oscillation of the lower exosphere giving rise to the pt type pulsation may be excited by solar charged corpuscles impinging on the auroral zone. The pc type pulsation may be caused by corpuscles impinging on the second auroral zone, whose latitude is higher than that of the usual auroral zone, hence giving rise to a higher order mode of oscillation due to higher latitude of a loop of oscillation, resulting in the shorter period of the pc type pulsation compared to that of the pt type pulsation. Some observational facts lead to speculation that the pc type pulsation is caused by a continuous flow of solar charged corpuscles, whose velocity may be of the order of 10^8 cm/sec, and that the pt type pulsation is due to corpuscles accelerated intermittently by magnetic clouds in a mean flow of solar corpuscles.

551.5

1997 GEOMAGNETIC PULSATION ACCOMPANYING WITH THE INTENSE SOLAR FLARE.

Y.Kato, T.Tamao and T.Saito.

J. Geomagn. Geoelect., Vol. 10, No. 4, 203-7 (1959).

A brief account of observed correlation between intense solar flares and geomagnetic pulsations during I.G.Y. Further, a simple model is examined to derive an equation for the perturbation field, solving approximately for the period eigenvalue.

551.5

1998 ON THE FREQUENCY OF GEOMAGNETIC PULSATION PC.

T.Yoshimatsu.

J. Geomagn. Geoelect., Vol. 10, No. 4, 208-13 (1959).

Using a preliminary three-month table of IAGA, the hourly frequency of pc, F, was calculated at each of the fourteen observatories in Europe-Africa and Japan-Australia longitudinal zones, for each month and each season during the period from October, 1957 to June, 1958. It was found that for each season the mean maximum hour interval of the frequency fell around 9-11 hr in local time for the most observatories. Secondly the ratio $F_m/\bar{F}$ where F_m is the * maximum and $\bar{F}$ the mean value of F for each season is introduced, and it shows a remarkable dependency on the geomagnetic latitude, though the most important regions both equatorial and auroral zones can not be introduced. It is suggested from these results that the outer atmosphere may become most sensitive in more extended depth than usual to the impinging solar agency over the earth within one or two days after the geomagnetic disturbances, probably in the higher geomagnetic latitudes.

551.5

1999 STUDIES ON THE LOCAL CHARACTER OF THE GEOMAGNETIC PULSATION, PC.

S.Utashiro.

J. Geomagn. Geoelect., Vol. 10, No. 4, 214-20 (1959).

It is well known that pc type pulsations occur simultaneously in a world wide region The author examined the induction magnetometer records at the four Japanese stations (Memanbetsu, Onagawa, Simosata and Kanoya). Results are as follows: (1) The local pc occurs frequently during daytime; (2) The maximum of occurrence frequency of local pc lies in equinox, and the minimum lies in winter; (3) The frequency of occurrence of local pc depends on local mean time, and the maximum frequency of its occurrence lies around 13 h (L.M.T.).

551.5

2000 PRELIMINARY STUDIES ON THE DAILY BEHAVIOUR OF RAPID PULSATION.

Y.Kato and T.Saito.

J. Geomagn. Geoelect., Vol. 10, No. 4, 221-5 (1959).

The daily variations of the period of the pc pulsation accompanied by ssc or si are analysed. It is found that the shortest period of these pulsations is long in the daytime and apparently becomes short at night, showing daily variations.

551.5

2001 SOME REMARKS ON THE MORPHOLOGY OF GEOMAGNETIC BAYS.

N.Fukushima.

J. Geomagn. Geoelect., Vol. 10, No. 4, 164-71 (1959).

The unequal occurrence frequency of positive and negative geomagnetic bays at various places over the world is attributable to the condition that most cases of geomagnetic bays are polar elementary storms, especially negative ones, the typical or idealized disturbance field of which is represented by an overhead current-system composed of an intense westward current of narrow longitudinal width along the auroral zone and the counter current flow over the whole remaining part of the world. This result must be carefully taken into consideration when the average current-system for geomagnetic bays is dealt with. The systematic rotation sense of the disturbing force vectors of bays observed everywhere in middle latitudes, clockwise in the forenoon and counter-clockwise in the afternoon, is a result of the systematic progressive change in the overhead current-system during the course of bays. Some other problems to be examined are also suggested.

551.5

2002 POSSIBLE ASYMMETRY IN THE DAILY RANGE OF THE GEOMAGNETIC VERTICAL INTENSITY AROUND THE MAGNETIC EQUATOR.

C.A.Onwumechilli.

Nature (London), Vol.184, 51 (July 4, 1959).

Contrasts briefly results from two magnetic observatories straddling the equator as a means of detecting an asymmetry in the vertical intensity on opposite sides of the equator. S.J.St-Lorant

551.5

2003 A NEW ANTENNA TO ELIMINATE GROUND WAVE INTERFERENCE IN IONOSPHERIC SOUNDING EXPERIMENTS.
R.S.MacMillan, W.V.T.Rusch and R.M.Golden.
J.atmos.terrest. Phys., Vol.13, No.1-2, 183-6 (1958).

551.5

2004 TEMPERATURE VARIATIONS IN THE REGION OF THE IONOSPHERE DURING THE SOLAR ECLIPSE OF 25 DECEMBER, 1954. M.W.McElhinny.
S. African J. Sci., Vol. 55, No. 11, 283-6 (Nov., 1959).

The possibility that temperature variations might explain deviations in the maximum electron density of the E-layer observed during the eclipse from the expected effects of a uniformly radiating disc is re-examined. It is found that these deviations can be explained on the basis of a drop in temperature to about three quarters of its value on control days.

551.5

2005 ON THE IONOSPHERIC CURRENT SYSTEM OF THE GEOMAGNETIC SOLAR FLARE EFFECT (S.F.E.).
H.Volland and J.Taubenheim.
J. atmos. terrest. Phys., Vol. 12, No. 4, 258-65 (1958).

A synoptical chart of the horizontal vectors of a geomagnetic s.f.e. and a comparison of the s.f.e. vectors of a number of selected effects at Niemegk shows, that the s.f.e. current system is not a simple enhancement of the S_q current system. The s.f.e. current system is an independent system having a phase difference between 15 and 30 deg. with respect to S_q system, and flowing in a level different from the S_q current level. A correlation between the respective intensities of geomagnetic s.f.e., sudden ionospheric disturbance, and E-layer effect, suggests that both the E-layer and the D-layer contribute to the geomagnetic s.f.e. From a number of selected effects the respective contributions of D- and E-layer are estimated as nearly equal.

551.5

2006 TURBULENCE IN THE IONOSPHERE WITH APPLICATIONS TO METEOR TRAILS, RADIO STAR SCINTILLATION, AURORAL RADAR ECHOES, AND OTHER PHENOMENA.
H.G.Booker.
Proceedings of the Polar Atmosphere Symposium II. Ionospheric Section (Oslo, 1956). Special Supplement to J. atmos. terrest. Phys., 1957, 52-81

The irregularities in electron density responsible for incoherent scattering of radio waves in the ionosphere are discussed on the assumption of isotropic turbulence in the neutral molecules, with allowance made for the effect of the earth's magnetic field on the associated irregularities in the density of the charged particles. The atmospheric model used is based on rocket observations, extrapolated upwards in height where necessary. Tentative formulae are deduced for the large eddies based on a nonstandard application of the Richardson number. For the small eddies the standard formulae of turbulence theory are used. These formulae all depend on a quantity w, which is the rate of supply of turbulence energy to the large eddies and also the rate of removal of turbulence energy from the small eddies, measured per unit mass of atmosphere. The value of w at the meteoric level (90 km) is found to be around 25 W/kg by comparison between the theory and meteoric observations (both visual and radio). By the same technique a more tentative value of 1000 W/kg is deduced for the level responsible for scintillation of radio stars although a lower value is probably appropriate when scintillation is weak. These values of w in the ionosphere are high compared with Brunt's value of 5×10^{-4} W/kg for the troposphere. It is shown, however, that these high values of w in the ionosphere are quite possible and even reasonable. It is also shown that radio star scintillation cannot be explained in terms of turbulence at a level of 400 km, but that reasonable results can be obtained if the level is reduced to 200-300 km.

551.5

2007 ON THE INTERPRETATION OF IONIZATION IN THE LOWER IONOSPHERE OCCURRING ON BOTH DAY AND NIGHT SIDE OF THE EARTH WITHIN A FEW HOURS AFTER SOME SOLAR FLARES. B.Hultqvist.
Tellus, Vol. 11, No. 3, 332-43 (Aug., 1959).

Some strong solar flares cause very strong absorption in high geomagnetic latitudes on both day and night sides of the earth. The absorption effect is measurable a few hours after the solar flare outbreak. It is shown that the effect can be interpreted as being caused by a high-energy-ion beam of very small density, emitted from the sun and moving in Störmer orbits.

551.5

2008 THE EFFECT OF CERTAIN SOLAR RADIATIONS ON THE LOWER IONOSPHERE. R.E.Houston, Jr.
J. atmos. terrest. Phys., Vol. 12, No. 4, 225-35 (1958).

An electron density distribution in the D and E regions of the ionosphere is computed. Lyman alpha, Lyman beta, the Lyman continuum and X-radiations are considered. The resulting electron distribution is used to compute parameters which may then be compared with data from rocket and long wave radio experiments. In general, there is good agreement between experimental results and the values predicted by the model.

551.5

2009 ON THE APPROXIMATE DAYTIME CONSTANCY OF THE ABSORPTION OF RADIO WAVES IN THE LOWER IONOSPHERE. S.Chapman and K.Davies.
J. atmos. terrest. Phys., Vol. 13, No. 1-2, 86-9 (1958).

By day, the absorption of very long radio waves is nearly constant, and decidedly greater than at night. It is here explained as due to electrons generated mainly by photodetachment from negative ions, supposed to be much greater in number, and nearly constant by day and night. The optical depth of the level concerned must be small for the photodetaching radiation, but large for the radiations able to ionize neutral particles.

551.5

2010 VERY LOW-FREQUENCY SPECTRA OF ATMOSPHERICS PROPAGATED THROUGH THE IONOSPHERE.
T.Obayashi.
Nature (London), Vol. 184, 34-6 (July 4, 1959).

An investigation of very low frequency atmospherics using radio-spectrometers covering the band 1-70 kc/s. Observations indicate a region of strong absorption around 2-4 kc/s and it is noted that night-time atmospherics have a maximum spectral intensity at about 8-10 kc/s while the day spectrum has its maximum near 15 kc/s. These and other data appear to confirm the mode theory of propagation enunciated by Budden (Abstr. 2863 of 1951) and elaborated by Wait (Abstr. 8032 of 1957). G.D.Sims

551.5

2011 A THEORY OF IONOSPHERIC RADIO WAVE SCATTERING UNDER THE INFLUENCES OF ION PRODUCTION AND RECOMBINATION. K.Maeda, S. Kato and T.Tsuda.
J. Geomagn. Geoelect., Vol. 10, No. 3, 91-8 (1959).

For the daytime E-layer ionospheric scatter propagation, the controlling solar influences cannot be neglected. To account for the experimental results obtained by Bailey et al. (1955), showing solar influences, a new theory is proposed which introduces the effects of ion production and recombination to Villars—Weisskopf's pressure theory. The electrons are assumed to be compressed or dilated at the same rate as the air itself, the latter being subject to adiabatic change of pressure, while the electrons and ions moving with the air molecules are produced by solar radiation and then recombined. The results obtained are quite satisfactory to account for the dependence of received scattered signal intensity on both frequency and scattering angle, at least concerning the daytime solar controlled scatter propagation in the E-region.

551.5 : 621.391.812.33

2012 POLARIZATION CHARACTERISTICS OF RADIO-WAVE PROPAGATION IN THE IONOSPHERE. Y.S.N.Murty.
Sci. and Culture, Vol. 25, No. 2, 161-2 (Aug., 1959).

Using the Appleton—Hartree formulae, equations are derived which describe the polarization of a radio wave propagated in the ionosphere. These equations are identical to those obtained by other workers using wave formulae. H.J.A.Chivers

551.5

2013 ELECTRON DISTRIBUTION IN A NEW MODEL OF THE IONOSPHERE. H.K.Kallmann.
Proceedings of the Polar Atmosphere Symposium II. Ionospheric Section (Oslo, 1956). Special Supplement to J. atmos. terrest. Phys., 1957, 82-7.

A theoretical analysis of the formation of the ionosphere has been made which has led to a model of the ionized regions at altitudes between 80 and 300 km above the earth's surface. The study is based primarily on a new model of the pressure, density, and temperature distribution derived from rocket observations, and upon solar radiation measurements, also made by means of rockets, above 90 km. The calculated electron density distribution is then compared with the electron densities measured directly at the pertinent altitudes, again by rockets carrying the measuring devices and telemetering equipment, again by rockets carrying the measuring devices and telemetering equipment.

551.5

2014 THE ELECTRON DISTRIBUTION IN THE IONOSPHERE OVER SLOUGH. II. DISTURBED DAYS.

J.O.Thomas and A.Robbins.

J. atmos. terrest. Phys., Vol. 13, No. 1-2, 131-9 (1958).

For Pt I see abstr. 2067 (1958). An account is given of how the heights of maximum electron density of the F1 and F2 layers and the sub-peak electron content vary over Slough (England) during magnetic storms. The parameters have been taken from detailed true-height electron density distributions calculated from observed h'(f) curves in 6 months representing three seasons in a year of low, and a year of high sunspot number. Attention is drawn to the fact that variations of h'F2 during a storm should not be taken to represent changes of height of the F2 layer. The heights of maximum electron density in the layers are found to increase in storms, particularly at night. Ionospheric storm effects are found to occur almost immediately after the magnetic changes.

551.5

2015 THE TRAPPING OF COSMIC RADIO WAVES BENEATH THE IONOSPHERE. G.R.Ellis.

J. atmos. terrest. Phys., Vol. 13, No. 1-2, 61-71 (1958).

The observation of cosmic radio noise at frequencies less than the local ionospheric critical frequency is discussed. It is shown that this effect may adequately be explained in terms of the trapping of the radiation between the ionosphere and the ground. Wherever there is a horizontal gradient of critical frequency in an ionospheric layer, incoming extra-terrestrial radiation may be reflected by the layer after one ground reflection and propagate by hop transmission for large horizontal distances beneath the layer. A method of calculating the amplitude of the trapped radiation at any distance is given, allowing for all possible methods.

551.5

2016 THE INTERPRETATION OF CHANGES IN THE E- AND F1-LAYERS DURING SOLAR ECLIPSES. C.M.Minnis.

J. atmos. terrest. Phys., Vol. 12, No. 4, 272-82 (1958).

Recent eclipse measurements have been explained in terms of the response of a Chapman layer to the obscuration of a solar disk on which localized sources of ionizing radiation are superposed on a uniformly bright background. This interpretation is supported by several features of the results obtained during a series of eclipses. An alternative interpretation postulates a complex layer containing two different species of ion but assumes only a uniformly bright solar disk. This hypothesis has been examined but calculations based on it result in expected changes in the layer, during an eclipse, which are not in accord with certain characteristics of the experimental data. A suggestion has been made that the layer tilts which occur during an eclipse may give rise to errors in the interpretation of the data. Experimental results are quoted which suggest that such errors are probably not important.

551.5

2017 HEIGHT-GRADIENT OF ELECTRON-LOSS IN THE F-REGION. V.Marasigan.

J. atmos. terrest. Phys., Vol. 13, No. 1-2, 107-12 (1958).

A theoretical expression is derived for the exponential height-gradient of the coefficient of electron-loss in the F-region, on the assumption that this gradient completely accounts for the initial process of bifurcation. Five models are proposed: parabolic, linear, second-power, cosine and quasi-parabolic.

551.5

2018 THE DIURNAL AND SEASONAL VARIATIONS OF SPREAD-F IONOSPHERIC ECHOES AND THE SCINTILLATIONS OF A RADIO STAR. B.H.Briggs.

J. atmos. terrest. Phys., Vol. 12, No. 2-3, 89-99 (1958)

A comparison is made of the spread-F ionosphere echoes observed at Slough (52°N) and Inverness (57°N). It is found that the degree of spreading is greater at the station of higher latitude. The diurnal and seasonal variations are similar at the two stations. The diurnal and seasonal variations of the scintillation index of the radio star in Cassiopeia are explained in terms of measured ionospheric parameters (spread-F index and critical frequency) together with the change of zenith angle of the source. A large seasonal anomaly which was previously thought to exist is found to be much reduced when all the relevant factors are taken into account.

551.5

2019 RADIO STAR SCINTILLATIONS AT AN EQUATORIAL STATION. J.R.Koster

J. atmos. terrest. Phys., Vol. 12, No. 2-3, 100-9 (1958).

Radio star scintillations have been observed at a frequency of 45 Mc/s over a period of 4 years at an equatorial station with a phase switching interferometer. Scintillation effects are found to be very severe, the output from even intense radio stars often dropping to zero. Scintillation occurs only at night, and is of nearly daily occurrence near sunspot maximum, correlating positively with the sunspot cycle. It correlates highly with the occurrence of spread-F echoes, but with no other geophysical phenomena. It is as yet unclear whether the observed results are due to absorption of the signal or can be accounted for by the impression of a much larger phase deviation on the emergent wave front by the diffracting screen responsible for scintillation. The phenomenon correlates highly with the trans-equatorial scatter of radio signals observed near sunspot maximum.

551.5

2020 THE EFFECT OF DIFFUSION ON THE VERTICAL DISTRIBUTION OF IONIZATION IN A QUIET F-REGION.

V.C.A.Ferraro and I.Özdoğan.

J. atmos. terrest. Phys., Vol. 12, No. 2-3, 140-9 (1958).

The vertical distribution of ions in a quiet F-region is calculated on the assumption that electrons disappear by attachment to neutral molecules and by diffusion. The coefficient of attachment, K, is assumed to be constant, and the coefficient of diffusion D is calculated from the classical theory of gases. Using values of the molecular air density and temperature in the F-region inferred from rocket data, it is found that diffusion produces a diurnal oscillation in the level of maximum ionization characterized by a rapid rise soon after sunrise followed by a slower fall of level which continues till dawn. Since this disagrees with the observed behaviour of the height of the F2-region, the diffusion coefficient may be too large by a factor of 10; also the value of K is likely to be smaller than that suggested in recent work of Ratcliffe et al. (1956) and that it is probably smaller than 10^{-4} sec^{-1} at levels lower than 300 km.

551.52

2021 ON THE EXCHANGE COEFFICIENT IN THE LOWEST LAYERS OF THE ATMOSPHERE. E.A.Ridel'.

Izv. Akad. Nauk SSSR, Ser. geofiz., 1959, No. 4, 632-4. In Russian.

A continuation of the work of Obukhov [Trudy Geofisicheskozo Instituta (Akad. Nauk SSSR) No. 24, 151 (1954)] on thermal exchanges in the lower layers of the atmosphere. J.M.Hough

551.51

2022 A GENERALIZATION OF RICHARDSON'S CRITERION OF TURBULENCE. I.Dugstad.

Meteorol. Ann., Vol. 4, No. 13, 331-50 (1958).

A mathematical analysis of turbulent motion in the atmosphere, taking into account the variations of mean velocity and temperature with horizontal distance as well as with vertical height, leads to the definition of three parameters which determine the character of the motion. Turbulence can persist under conditions which neither Richardson's nor Arakawa's criterion would predict. The range of directions of mass transfer that correspond to an increase of the turbulent motion is defined in terms of the local values of the absolute vorticity, Richardson's number, and the horizontal wind shear. J.G.Oldroyd

551.5

2023 RANDOM REFLECTIONS ON THE HISTORY OF ATMOSPHERIC OPTICS. W.E.K.Middleton.

J. Opt. Soc. Amer., Vol. 50, No. 2, 97-100 (Feb., 1960).

The history of ideas on the blue of the sky, the rainbow, and the visibility of distant objects is briefly sketched. In particular, it is shown that the theory of the horizontal visual range was largely rediscovered after about 175 years.

551.5

2024 DISTRIBUTION OF INFRARED RADIANCE OVER A CLEAR SKY. H.E.Bennett, J.M.Bennett and M.R.Nagel.

J. Opt. Soc. Amer., Vol. 50, No. 2, 100-6 (Feb., 1960).

Series of measurements of the distribution of radiance over a clear sky made from locations at approximately 1000, 6000 and 14 000 ft elevation are reported. A theoretical relation is shown to correctly predict the observed variation in radiance with elevation angle in the 2-40 μ wavelength region, where radiation from the sky is mainly due to thermal emission by the atmosphere. In the 0.6-2 μ region where the radiation is mainly scattered sunlight the distribution is related to that which was observed simultaneously in the visible but forward scattering is relatively more important in the near infrared and the relative intensities in the two regions are not constant.

551.5

2025

ATMOSPHERIC ABSORPTIONS IN THE NEAR INFRARED AT HIGH ALTITUDES.

D.G.Murcray, J.N.Brooks, F.H.Murcray and W.J.Williams.

J. Opt. Soc. Amer., Vol. 50, No. 2, 107-12 (Feb., 1960).

The results of a flight with a balloon borne infrared spectrograph are presented. Solar spectra of the region from 1 to 5 μ were obtained at altitudes from 60 000 to 100 000 ft. The atmospheric absorption data obtained from these spectra are compared with theoretical predictions of slant path absorptions and with laboratory data for constant pressure path. It is found that, if the absorption is treated as a function of Pw, the laboratory data and flight data can be fitted by relations of similar form but with different constants.

551.5

2026

THE CHARACTERISTIC SIZE OF AIRGLOW CELLS.

F.E.Roach, E.Tandberg-Hanssen and L.R.Megill.

J. atmos. terrest. Phys., Vol. 13, No. 1-2, 113-21 (1958).

Evidence is presented for the existence of discrete 5577 airglow cells in the upper atmosphere. Independent analyses are based on (a) the comparison of diurnal intensity variations in different parts of the sky and (b) the measurement of intensity gradients on airglow isophote maps. The numerical estimation of cell size is complicated by the fact that a single cell is, in general, larger than the region observable at a given location. The typical airglow cell for the 12 nights of the study has a diameter of approximately 2500 km.

551.5

2027

MOVEMENTS OF AIRGLOW CELLS.

F.E.Roach, E.Tandberg-Hanssen and L.R.Megill.

J. atmos. terrest. Phys., Vol. 13, No. 1-2, 122-30 (1958).

The possibility of translatory and rotatory motions of airglow cells is examined. Evidence is presented for translatory motions in the 100 km region with speeds of the order of 100 m/sec. Rotatory motions are indicated corresponding to a mean period of 5 hr. A broad similarity seems to exist between airglow cell motions in the 100 km region and vortex cells near sea level. The problem of the mechanism responsible for the excitation of the oxygen atom to the ^1S state is discussed with particular reference to (a) photochemical reactions and (b) environmental effects.

551.5

2028

$^1\Delta g$-$^3\Sigma g$-O_2 INFRARED EMISSION BAND IN THE TWILIGHT AIRGLOW SPECTRUM.

A.V.Jones and A.W.Harrison.

J. atmos. terrest. Phys., Vol. 13, No. 1-2, 45-60 (1958).

The 0,1 $^1\Delta g$-$^3\Sigma g$-O_2 emission band has been observed at 1.58 μ in the evening twilight spectrum obtained with a PbS infrared spectrometer. The band is absent in the morning twilight. The absolute brightness and decay of the emission for a constant zenith distance in the sun-zenith plane has been measured. The measurements have been compared with calculations of the brightness of the bands to be expected as a result of either a resonance phosphorescence excited by infrared solar radiation or by the reaction between atomic oxygen and ozone.

551.5

2029

RESONANCE SCATTERING BY ATMOSPHERIC SODIUM. IV. ABUNDANCE OF SODIUM IN TWILIGHT.

J.W.Chamberlain, D.M.Hunten and J.E.Mack.

J. atmos. terrest. Phys., Vol. 12, No. 2-3, 153-65 (1958).

For Pt III see Abstr. 1793 (1957). The theory of Pt I is extended to take account of the hyperfine structure of the D-lines. The absolute intensity of $D_1 + D_2$ and the ratio D_2/D_1 are computed as functions of total Na abundance for an angle of solar depression, β, of 6.5°. Observations made in Saskatoon are discussed in terms of the seasonal variation of Na. Abundance determinations from the D_2/D_1 ratio in twilight and from the terrestrial component of D-line absorption in the solar spectrum are in good accord with abundances deduced from the absolute twilight intensity.

551.5

2030

RESONANCE SCATTERING BY ATMOSPHERIC SODIUM. V. THEORY OF THE DAY AIRGLOW.

J.C.Brandt and J.W.Chamberlain.

J. atmos. terrest. Phys., Vol. 13, No. 1-2, 90-9 (1958).

Chandrasekhar's theory of radiative transfer is applied to the day airglow to obtain the D_2 and D_1 brightness as a function of the sodium abundance and ground albedo. An analytic method of integrating monochromatic intensities over a Doppler profile has been developed, eliminating the necessity for numerical quadratures. This method is general and could be used to simplify calculations in the twilight and night airglow sodium problems as well. A high ground albedo can nearly double the radiation incident on the sodium "layer", compared with direct sunlight alone. A general derivation is given of Hunten's (Part III) approximation for an effective optical thickness.

551.5

2031

RESONANCE SCATTERING BY ATMOSPHERIC SODIUM. VI. THE ANALYTIC SOLUTION FOR THE TWILIGHT INTENSITY.

J.C.Brandt.

J. atmos. terrest. Phys., Vol. 13, No. 1-2, 100-6 (1958).

With the method outlined by Brandt and Chamberlain (1958), (see preceding abstract), the analytic solution for the twilight intensity is obtained in terms of rapidly converging series of expressions. All of the necessary functions for the solution are tabulated, and it is found that three terms of the series give an error less than 0.5% for the range $0 \leq \tau_0 \leq 0.20$. A sample computation is made for an angle of solar depression β, of 6.5°, and the values are in excellent agreement with the numerical work published previously.

551.5

2032

THE SEASONAL VARIATION OF THE INTENSITY RATIO OF THE D-LINES IN TWILIGHT.

A.V.Jones and D.H.McPherson.

J. atmos. terrest. Phys., Vol. 12, No. 2-3, 166-70 (1958).

The intensity ratio of the sodium D-lines in twilight has been measured over the period from May 1955 to July 1956 from photographic spectra obtained with an auroral spectrograph having a dispersion of 30 A/mm. Significant variations of the D_2/D_1 line ratio were found, ranging from a mean value of 1.40 ± 0.08 for the period from December to February to a value of 1.67 ± 0.20 for the period from May to June. The abundances of sodium calculated from these ratios are in agreement with abundances calculated from the absolute brightness and the direct absorption methods. The measurements are in good agreement with the theoretical calculations of Chamberlain, Hunten and Mack (1957).

551.5

2033

THE CORRECTION OF SODIUM TWILIGHT GLOW OBSERVATIONS.

T.M.Donahue and D.M.Hunten.

J.atmos.terrest. Phys., Vol.13, No.1-2, 165-6 (1958).

551.5

2034

THE HEIGHT OF NIGHTGLOW 5577.

F.E.Roach, L.R.Megill, M.H.Rees and E.Marovich.

J. atmos. terrest. Phys., Vol. 12, No. 2-3, 171-86 (1958).

An analysis is given of observations of nightglow 5577 during twelve nights at Fritz Peak, Colorado. A new photometer with a birefringent filter effectively eliminates light of astonomical origin. The heights deduced from the systematic increase of the nightglow intensity toward the horizon depend critically on the scattering and extinction of the lower atmosphere. It is found that, if a constant extinction coefficient is used in the reductions for all the nights, the spread in deduced heights is from 51 to 136 km with 100 km as the mean value. A more probable interpretation is that the actual height is 100 km and that the extinction coefficient varies from night to night. For an entire night of data the uncertainty in the extinction produces the largest error in the deduced height. On the other hand, at a given instant the spottiness of the sky is the predominant source of error.

551.5

2035

THE EMISSION SPECTRUM OF NIGHT SKY IN THE 1.2-3.4 μ REGION.

V.I.Moroz.

Dokl. Akad. Nauk SSSR, Vol. 126, No. 5, 983-6 (June 11, 1959).
In Russian.

A diffraction-grating (300 lines/mm) photoelectric spectrometer was used to record the night-sky spectrum in November and December 1958, at Loparskaya (near Murmansk, $\varphi = 68^\circ 38'$, $\lambda = 33^\circ 20'$). In the 1.2-2.5 μ region OH bands were observed; they were emitted by the upper atmosphere. In the 2.5-3.5 μ region thermal radiation of the troposphere was recorded.

A.Tybulewicz

551.5

2036 EFFECTS OF THE SOLAR FLARES OF 7 JULY 1958. OBSERVED AT KIRUNA GEOPHYSICAL OBSERVATORY, SWEDEN. B.Hultqvist, J.Aarons and J.Ortner.
Tellus, Vol. 11, No. 3, 319-31 (Aug., 1959).

The very strong effects in the auroral zone of the solar flares of 7 July 1958 as observed at Kiruna Geophysical Observatory by means of magnetometer, an ionospheric sounder, a cosmic noise absorption receiver (riometer), oblique auroral reflection receivers, transpolar communications receivers, and cosmic ray telescopes are reported and discussed. Several remarkable features of the terrestrial disturbances were observed: 1. Extremely strong absorption became apparent a few hours after the solar flare. In spite of a linearly increasing absorption during the first seven hours after the flare no change in height or critical frequency of the F2 layer was noted during this period. 2. The S.I.D.s reported by Pacific Observatories at the time of the flares were not observed at Kiruna although Kiruna was on the sunlit side of the earth. 3. A magnetic storm and a large decrease in the counting rate of the meson component of cosmic radiation appeared simultaneously 31 hours after the flare. 4. The maximum absorption at 27.6 Mc/s recorded during this period surmounted 20 dB.

551.5

2037 QUANTITATIVE MEASUREMENTS OF ABSORPTION IN THE AURORAL ZONE. F.Lied.
Proceedings of the Polar Atmosphere Symposium II. Ionospheric Section (Oslo, 1956). Special Supplement to J. atmos. terrest. Phys., 1957, 135-46

Ionospheric recordings at polar stations have generally indicated that the normal level of ionospheric absorption is high, but also frequent occurrence of excessive absorption and of polar radio blackouts even during mild magnetic disturbances. Such disturbances constitute a serious handicap to radio communication which passes near the auroral zone. Quantitative knowledge of both the normal ionospheric absorption and of these disturbances is far from complete and clarity of the physical mechanism involved is partly lacking in spite of considerable knowledge of the statistical properties of the disturbances. Likewise, of course, from a practical point of view one would very much like to be able to predict both the normal and the occurrence of excessive radio absorption. This paper considers the available technique which may be brought to bear on the problems and briefly summarizes the published results of quantitative measurements chiefly from Canada and U.S.A. and compares them with some work done in Norway.

551.5 : 539.19

INTERPRETATION OF ROTATIONAL TEMPERATURES OF AURORAL N_2^+ BANDS. I. PROTON IMPACT AT INTERMEDIATE ENERGIES. See Abstr. 1494

551.5

2038 VARIATIONS IN THE INTENSITY OF THE HYDROGEN EMISSION LINE Hβ DURING AURORAL ACTIVITY.
G.J.Romick and C.T.Elvey.
J. atmos. terrest. Phys., Vol. 12, No. 4, 283-7 (1958).

Through the qualitative analysis of the auroral spectrum incident from the magnetic zenith, the variation of the estimated intensity with time has been obtained for Hβ (4863 A) and the 4709 A line of N_2^+. The results show that the peak in intensity of Hβ preceeds that of the 4709 A line by 1-4 hr, and that the period in which the intensity of Hβ peaks occurs when quiet forms of the aurora are present. This same period is associated with low amplitude low frequency fluctuations of N-S earth potential. The overall earth potential fluctuation is highly correlated with the intensity variations of the 4709 A line of N_2^+ and with the type of aurora present at the zenith.

551.5

2039 RADIO REFLECTIONS ON LOW FREQUENCIES FROM 75-90 km HEIGHT DURING INTENSE AURORA ACTIVITY. W.Stoffregen.
J.atmos.terrest.Phys., Vol.13, No.1-2, 167-9 (1958).

551.5

2040 TRITIUM AND DEUTERIUM CONTENT OF ATMOSPHERIC HYDROGEN.
F.Begemann and I.Friedman.
Z. Naturforsch., Vol. 14a, No. 12, 1024-31 (Dec., 1959).

The tritium and deuterium content was measured of 24 samples of atmospheric hydrogen collected at ground level near Buffalo, N.Y. (U.S.A.), Hamburg (Germany), and Nürnberg (Germany) during 1954 to 1956. At the beginning of 1954 the T/H-ratio was found to be 9.18×10^{-14}, i.e. about a factor of 10 higher than 1949 (Faltings and Harteck) and 1951 (v. Grosse et al.), probably due to the first explosion of a thermonuclear device in November 1952. In spite of a major test series of thermonuclear weapons in spring of 1954 (Operation Castle) no further increase in the tritium content was found during 1954 and 1955. It shows instead a seasonal variation with low tritium content in summer and about a threefold higher one in winter. Simultaneously, there is a good correlation between the tritium and deuterium concentrations. From 1956 on, a noticeable increase in the tritium content due to more man-made HT produced or released by thermonuclear devices into the atmosphere was found, in agreement with measurements by Gonsior. A possible explanation of the experimental results, as well as a mode to test the validity of the model suggested, is given. The deuterium concentrations of the samples analysed vary between about +7% and -17%, compared with Standard Lake Michigan Water with a ratio D/H = 0.0148 ± 0.0002 mol per cent. Although from these results only a correlation factor between the tritium and deuterium content of "mean atmospheric hydrogen" and not their absolute values can be derived it is obvious that atmospheric hydrogen and the water vapour of the atmosphere are not in thermodynamic equilibrium, as has been pointed out before by Harteck and Suess.

551.5 : 537.59

2041 ON THE PRODUCTION OF RADIOISOTOPES IN THE ATMOSPHERE BY COSMIC RADIATION AND THEIR APPLICATION TO METEOROLOGY.
D.Lal, P.K.Malhotra and B.Peters.
J. atmos. terrest. Phys., Vol. 12, No. 4, 306-28 (1958).

Cosmic radiation produces, in the atmosphere, various radioisotopes which are efficiently collected during the condensation of moisture and can be detected in rain-water. The production rates of various radioisotopes, mainly those whose half-lives make them suitable for studying meteorological phenomena, have been calculated for all parts of the atmosphere, and are presented in graphical form. For the isotope, Be^{10}, whose half-life is long compared to the characteristic time of mixing between the stratosphere and the troposphere, the fall-out rate agrees with the calculated production rate. For the isotopes, Be^7, P^{33}, and P^{32}, whose half-lives are short compared to the characteristic time of mixing between the stratosphere and the troposphere, the measured fall-out rates agree with the calculations under certain assumptions. Tentative measurements on the fall-out of S^{35} activity indicate an appreciably higher rate than calculated.

551.5

2042 ON THE ANOMALY FOUND IN AEROPLANE γ-RAY SURVEYS. A.F.Yakovlev.
Izv. Akad. Nauk SSSR, Ser. geofiz., 1958, No. 5, 594-604. In Russian. English summary: PB 141042T-4, obtainable from Office of Technical Services, U.S. Dept. of Commerce, Washington, D.C., U.S.A.

Anomalously high values of the γ-field at a height of several hundred metres above the earth's surface may indicate a deposit of radioactive material. An attempt is made to determine the actual γ-field from the instrumental records obtained at any height.

E.W.Kellermann

551.5 : 539.1.07

2043 THE MEASUREMENT OF THE LIGHT ATMOSPHERIC ION SPECTRA. L.R.Tsvang and L.N.Gutman.
Izv. Akad. Nauk SSSR, Ser. geofiz., 1958, No. 7, 891-902. In Russian. English summary: PB 141042T-3, obtainable from Office of Technical Services, U.S. Dept. of Commerce, Washington, D.C., U.S.A.

A method is described of solving integral equations that are characteristic of transient processes in ion chambers. The dependence of the atmospheric light ion spectrum upon the presence and development of clouds was studied using airborne ion spectrometers. Presence of clouds decreased both positive and negative ion concentration which were restored when the clouds cleared.

R.W.Nicholls

551.5
2044 THE DOUBLE FIELD-MILL.
M.Smiddy and J.A.Chalmers.
J. atmos. terrest. Phys., Vol. 12, No. 2-3, 206-10 (1958).

A double field-mill is described which is automatically brought to the potential of its surroundings and also registers the potential gradient at a point above ground level.

BIOPHYSICS · PHYSIOLOGICAL PHYSICS

Hearing . Speech

612.7 : 621.395.61
2045 TOWARD A MODEL FOR SPEECH RECOGNITION.
K.N.Stevens.
J. Acoust. Soc. Amer., Vol. 32, No. 1, 47-55 (Jan., 1960).

An approach to the design of a machine for the recognition and synthesis of speech is proposed, with particular emphasis on problems of acoustical analysis. As a recognizer, the proposed machine accepts a speech wave at its input and generates a sequence of phonetic symbols at its output; as a synthesizer it accepts a sequence of symbols at its input and generates a speech wave. Coupling between the acoustical speech signal and the machine is achieved through two peripheral units: one an analog filter set or equivalent, and the other a model of the vocal tract. Between the analog filters and the phonetic output the signal undergoes an intermediate form of representation that is related to vocal-tract configurations and excitations but is not necessarily described specifically in these terms. Each stage of analysis is performed by synthesis of a number of alternative signals or patterns according to rules stored within the machine and by comparison of the synthesized patterns with the input signals that are under analysis. Possible advantages of the proposed method of analysis are discussed. An experimental study based on the general analysis approach is described. In this study a method for the determination of the frequencies of vocal-tract resonances from the speech wave is simulated on a digital computer.

612.8
2046 EXPERIMENTAL STUDY OF BONE CONDUCTION IN EARS WITH MECHANICAL IMPAIRMENT OF THE OSSICLES. J.P.Legouix and S.Tarab.
J. Acoust. Soc. Amer., Vol. 31, No. 11, 1453-7 (Nov., 1959).

The cochlear-microphonic potential of guinea pigs was recorded during stimulation by bone-conducted sounds. The amplitude and the phase of the response were measured while the ossicles were altered in various ways. At low and middle frequencies, fixation of the ossicular chain produces a decrease of amplitude and a phase advance of about 70°, while an increase of the mass yields an increase of amplitude and a phase lag greater than 180°. A progressive increase of the mass, produced by introducing paraffin oil in the middle-ear cavity, yields a progressive variation of amplitude and phase and, at a particular moment, a complete disappearance of the response. Symmetrical results were obtained by altering the intrabullar pressure. All these results are interpreted as showing the participation of several mechanisms contributing to the whole response. At low frequencies a translational mechanism involves two components: one related to the motion of the ossicular chain and the other related to the motion of the perilymphatic fluid. These two components contribute to the whole response according to their amplitude and phase. At higher frequencies a compressional mode of bone conduction, independent of the motion of the ossicles, is responsible for the stimulation. The findings agree with the alteration of bone conduction observed in clinical cases and provide an explanation for the lateralization of the sound source in an ear affected by conductive deafness, as shown in the Weber test. This lateralization may be accounted for by the observed phase shifts.

612.8
2047 LATENT AND RESIDUAL EFFECTS IN TEMPORARY THRESHOLD SHIFT. W.D.Ward.
J. Acoust. Soc. Amer., Vol. 32, No. 1, 135-7 (Jan., 1960).

Three experiments designed to examine latent effects of low noise-level stimulation gave completely negative results. It is concluded that noises that do not themselves produce temporary threshold shift have no effect on the growth or decay of temporary threshold shift produced by higher level exposures.

612.8
2048 LATERALIZATION THRESHOLD AS A FUNCTION OF STIMULUS DURATION. J.V.Tobias and S.Zerlin.
J. Acoust. Soc. Amer., Vol. 31, No. 12, 1591-4 (Dec., 1959).

Measurement on experienced listeners of interaural time difference (I.T.D.) thresholds for wide-band random noise indicates that the threshold varies systematically with duration of stimulation. In order to determine the point at which increase in duration no longer decreases I.T.D. threshold, stimulus (noise burst) duration was varied between 0.01 and 1.94 sec. A given I.T.D. was maintained throughout any particular burst, starting time included. All stimuli were presented at a level of 65 dB S.P.L. to each phone. The "duration" versus "I.T.D. threshold" function reaches asymptote at approximately 0.7 sec, indicating that the binaural system which effects the comparison necessary for a laterialization judgment may integrate information over that period for the kind of stimulus used.

612.8
2049 EFFECTIVE ONSET DURATION OF AUDITORY STIMULI. J.V.Tobias and E.D.Schubert.
J. Acoust. Soc. Amer., Vol. 31, No. 12, 1595-605 (Dec., 1959).

In analysing interaural temporal relations, the binaural system may receive information from one or more of three separate stimulus aspects: (1) difference in time of the start of stimulation; (2) difference in time between similar portions of the continuing wave form at the two ears; and (3) difference in time of the end of stimulation. In this study, the first and third kinds of difference were combined for convenience as "transient disparity"; the second was called "ongoing disparity". The relative effectiveness of these two temporal relations in producing changes in auditory localization was investigated by finding, for various values of transient disparity, a value of ongoing disparity that brought the sound back to centre. For a given value of transient disparity, the necessary ongoing disparity value varies as a function of stimulus duration. Transient disparity loses its effectiveness for stimulus durations greater than about 150 msec. For a duration of 100 msec, it takes roughly 35 times as much transient disparity as ongoing disparity to bring the sound to centre; for a duration of 30 msec, it takes about 7 times as much; and for a duration of 10 msec, 4 to 5 times as much. From the working hypothesis that the relative values of transient and ongoing disparities are directly proportional to the durations over which each cue is operative, an "effective onset duration" appears to lie between 2 and 4 msec.

612.8
2050 CURVES OF EQUAL LOUDNESS FOR OCTAVE BAND-PASS NOISE. G.Jahn.
Hochfrequenztech. u. ElektAkust., Vol. 67, No. 6, 187-9 (March, 1959). In German.

Apparatus is described in which a "white" noise generator supplies current through an octave bandpass filter to loudspeakers in a room having a reverberation time of 2-3 sec. 4 loudspeakers were mounted in corners of the room to produce a diffuse sound field. Signals of 1.3 sec duration with separating pauses of 0.3 sec were used. Equal loudness curves over a range of frequency 100 to 12 800 c/s were recorded by means of a Pegel-Schreiber, and are shown for three different observers. A.B.Wood

612.8
2051 ROLE OF INTERAURAL TIME AND INTENSITY DIFFERENCES IN THE LATERALIZATION OF LOW-FREQUENCY TONES. G.Moushegian and L.A.Jeffress.
J. Acoust. Soc. Amer., Vol. 31, No. 11, 1441-5 (Dec., 1959).

In the present series of experiments the method used was that of having the subject adjust the interaural time relation for a noise until it appears to be in the same lateral position as the stimulus tone. Using this procedure, results were obtained which support the findings of other recent workers, that increasing the intensity of the stimulus to an ear will cause it to transmit earlier in time.

Additional evidence was found, however, which shows that the central nervous system, too, responds to interaural intensity differences, and that its response is different from that of the peripheral system. When time and intensity are opposed, time has less effect on it than when time and intensity both favour the same side.

612.8

2052 INTERAURAL NOISE CORRELATIONS: EXAMINATION OF VARIABLES.

I.Pollack and W.Trittipoe.

J. Acoust. Soc. Amer., Vol. 31, No. 12, 1616-18 (Dec., 1959).

The identification of interaural noise correlations was examined as a function of the: duration, sound level, frequency range, and interaural balance of the noise. Progressive changes in identification performance were observed with changes in the individual variables.

612.8

2053 PURE-TONE CROSS-EAR LOCALIZATION EFFECTS.

W.R.Thurlow and L.F.Elfner.

J. Acoust. Soc. Amer., Vol. 31, No. 12, 1606-8 (Dec., 1959).

Experiments are reported on the effect of a tone in one ear on the localization of a tone in the other ear. Localization effects were systematically explored with low frequencies at 30 dB sensation level, the frequency in one ear being a simple n/1 multiple of that in the other. With this procedure, localization effects can be obtained between low-frequency tones (below 1000 c/s) of widely differing frequencies. If multiples are not used, localization effects occur only within narrower frequency limits for low frequencies. Thresholds for difference between the frequencies in the two ears within which the localization effect occurs increase systematically as one goes from low- to high-frequency regions. The localication effects on a given tone cause this tone to be perceived as "pulled-in" from the side location that it had when sounded alone.

612.8

2054 BACKWARD MASKING.

J.M.Pickett.

J. Acoust. Soc. Amer., Vol. 31, No. 12, 1613-15 (Dec., 1959).

An experiment was carried out to explore the auditory masking effect of a noise burst on a preceding weak stimulus. A short 1000 c/s tone preceded a burst of white noise by a variable silent interval. The threshold intensity level of the tone was taken as a measure of the masking provided by the noise burst. The effects were examined of combinations of the following conditions: tone durations of 5, 10, 15, 20, 25, and 50 msec; silent intervals of 0, 2, 5, 10, 25, and 100 msec; and noise burst levels ranging from 50 to 130 dB S.P.L. Appreciable elevations of tone threshold were observed for silent intervals less than 25 msec. Threshold elevations increased progressively as noise burst level was increased. The latter effect increased with shorter silent intervals. The tone-noise interval was a more critical factor than tone duration.

612.8

2055 PURE-TONE MASKING.

A.M.Small, Jr.

J. Acoust. Soc. Amer., Vol. 31, No. 12, 1619-25 (Dec., 1959).

The influence of one pure tone on the threshold of another was investigated. In contrast to previous experiments, masking in the present experiment was studied by determining the level of the masker necessary to mask a signal as a function of the frequency of the masker. The level and frequency of the signal served as parameters. The general forms of the masking functions are similar to those reported previously, but vary in several details. The maximum masking effect occured when the frequency of the masker approximated that of the signal. When the masker frequency was greater than that of the signal the slope of the masking function was very steep, 150-280 dB/octave depending upon signal level and frequency. This slope tended to be steeper at higher signal levels and, although less marked, also at higher signal frequencies. When the masker frequency was about 0.85 that of the signal an irregularity appeared in the masking curves. The size of this hump increased as signal frequency and level increased. Its frequency location seemed to rule out aural harmonics as a cause and its presence was tentatively related to perception of envelope modulation. The data are discussed from the points of view of band-pass filter analogue and compared to studies of previous investigators. In general the present findings represent an extension of pure-tone masking data with wider ranges of stimuli and a different method than those previously used.

612.8

2056 CONFIDENCE RATINGS, SECOND-CHOICE RESPONSES, AND CONFUSION MATRICES IN INTELLIGIBILITY TESTS.

F.R.Clarke.

J. Acoust. Soc. Amer., Vol. 32, No. 1, 35-46 (Jan., 1960).

The studies reported in this paper have dealt with the responses of human observers to speech stimuli transmitted in a background of white Gaussian noise. In all cases the listeners attempted to identify the transmitted items and then made a second response in an attempt to convey additional information. It was found that when the listeners were allowed a second-choice identification response, very little information was contained in these responses which was not already contained in the listeners' first-identification response. When the second response was a confidence rating, a significant amount of information was added to that which was carried by the identification response. The rating which followed each identification response was assigned by the observers in an attempt to estimate the probability that their identification response was, in fact, correct. For message sets of four items and for sets of sixteen items, it was found that the observers were quite capable of making such estimates over a wide range of speech-to-noise ratios. Their estimates did appear to be affected to some extent by the size of the message set and by the speech-to-noise ratio, but this interaction was slight. The observers' rating responses were used to generate ROC curves. These curves were adequately fit by straight lines when the data were plotted on normal—normal probability paper. Regardless of the size of the message set, all curves, for all speech-to-noise ratios, were fit by a single slope. However, the point at which these curves intersected the abscissa was a function of both variables. Data from one set of observers in the rating experiments were used in an attempt to predict the performance of a different group of observers whose task was to monitor subsets of messages. While predictions were fairly good, discrepancies were noted. An internal check in the monitoring experiment strongly suggests that these discrepancies arose because of differences between the two groups of observers.

612.8

2057 AUDITORY DETECTION OF A NOISE SIGNAL.

D.M.Green.

J. Acoust. Soc. Amer., Vol.32, No.1, 121-31 (Jan., 1960).

Measurements of the detectability of a noise signal in noise are reported in this paper. Paramaters of the noise signal such as the band width, duration, and centre frequency are investigated. The results are compared with an optimum-detection model. For some constant detectability the equation generated by the model and one constant, an attenuation factor, closely fit the experimental data over the major range of the experimental paramaters. The major area of discrepancy between model and data is the shape of the psychophysical function. Implications of the data for the critical-band mechanism are also discussed.

Vision

612.8

2058 ABSOLUTE VISUAL THRESHOLD AND AGE.

S.M.Luria.

J. Opt. Soc. Amer., Vol. 50, No. 1, 86-7 (Jan., 1960).

The absolute threshold of vision increases about threefold between the ages of 20 and 72. R.A.Weale

612.8

2059 RESPONSE FUNCTIONS.

G.A.Fry.

J. Opt. Soc. Amer., Vol. 49, No. 12, 1226-7 (Dec., 1959).

The projective transformation of the C.I.E. diagram previously reported (Abstr. 960 of 1959) is modified by means of a new restriction. R.A.Weale

612 .8

2060 CHROMATIC AND SHORT TERM DARK ADAPTATION OF THE HUMAN ELECTRORETINOGRAM.

J.C.Armington.

J.Opt. Soc. Amer., Vol. 49, No. 12, 1169-75 (Dec., 1959).

The human electroretinogram was elicited by test flashes which followed 2.5 sec after the termination of a coloured adaptation. Typically, the electroretinogram consisted of a negative wave followed by a double positive deflection. The negative wave gave evidence of mixed photopic-scotopic activity. The first positive wave showed high red photopic sensitivity when elicited by long wavelength test flashes and scotopic sensitivity when elicited by short wavelength test flashes. The second positive wave was scotopic. When mixed photopic-scotopic activity was present, the negative wave showed a higher proportion of photopic activity than did the positive wave. Blue adaptation favoured photopic response while red adaptation permitted an increase in scotopic sensitivity.

612.8

2061 NEURAL FORMULATION OF THE EFFECTS OF TARGET SIZE AND SHAPE UPON VISUAL DETECTION. W.M.Kincaid, H.R.Blackwell and A.B.Kristofferson.
J. Opt. Soc. Amer., Vol. 50, No. 2, 143-8 (Feb., 1960).

A hypothesis is presented, the chief assumptions of which are that neural impulses originating in retinal receptors converge upon neurons in a central area, and that the excitation of the most excited neuron in that area determines the response. The relation of this hypothesis to earlier ideas along similar lines is discussed. It is shown that the hypothesis leads to testable relationships between thresholds for circular targets and for targets of other shapes. Evidence is presented that diffuse neural connections are relatively more important at low background levels, and an interpretation is suggested.

612.8 : 523

STAR VISIBILITY IN DAYLIGHT AT HIGH ALTITUDES.
See Abstr. 843

TECHNIQUE . MATERIALS

62

2062 HIGH-TEMPERATURE PRESSURE-VACUUM FURNACE. W.Lodding and L.Hammell.
Rev. sci. Instrum, Vol.30, No.10, 885-6 (Oct., 1959).

A simple high-temperature pressure-vacuum furnace is described using a recrystallized alumina tube as the vessel with external resistance windings. Temperatures to 1900°C can be used in both strongly reducing and oxidizing atmospheres. Pressures to 28 atm at 1200°C were obtained and no water cooling was required. Differential thermal analysis with continuous gas analysis of reaction products is made possible.

62

2063 PRACTICABILITY AND LIMITATIONS OF THE ELECTROMAGNETIC ORIENTATION OF CORE DRILLS. F.Trey.
Z. angew. Phys., Vol. 11, No. 5, 169-72 (May, 1959). In German.

This is a theoretical treatment of the principles of the electromagnetic method of controlling a core drill; a formula is derived for the case where the borehole deviates from the vertical.
H.J.H.Starks

621.9 : 539.27

2064 A NON DESTRUCTIVE TECHNIQUE FOR EXAMINING SURFACES: APPLICATIONS TO METALLURGY AND MECHANICS. P.A.Jacquet.
Tech. mod., Vol. 51, No. 9, 465-70 (Sept., 1959). In French.

An electrolytic buffing tool is described for preparing small areas on metallic surfaces for microscopic examination or for replicas to be taken for electron-microscopic examination. The too has a hemispherical end which is water-cooled internally and dipped into a suitable electrolyte. The tool is supplied at 25 to 35 V d.c. and the electrolytic polishing or etching takes place within the meniscus formed by the drop of liquid on the surface. A.C.Whiffin

69

2065 PROBLEM OF PRODUCING SOLID MATERIALS OF HIGH PURITY, PARTICULARLY FOR SEMICONDUCTO WORK. G.Iwantscheff.
Z.Elektrochem., Vol.63, No.8, 876-82 (1959). In German.

Physical and chemical methods of analysis and purification are reviewed; the chemical purification of Si, Ge, In, Ga and Al are considered separately. It is concluded that improved methods must be devised, which exclude the possibility of contamination by the atmosphere, by the container walls and by the chemical reagents used. B.T.M.Will

LIST OF JOURNALS

The following list supplements the List of Journals to be published with the Index to Volume 62 (1959). Reprints of the List of Journals will be obtainable from The Institution of Electrical Engineers, Savoy Place, London, W.C.2, price 2s.0d. post free.

The addresses given are believed to be correct at the date of publication, but no responsibility can be accepted for errors.

Math. Comput.	Mathematics of Computation (Formerly: Mathematical Tables and Other Aids to Computation [Math. Tables Aids Comput.]) Publishers: The National Academy of Sciences—National Research Council. Subscription address: The Printing and Publishing Office, The National Academy of Sciences, 2101 Constitution Avenue, Washington 25, D.C.
Math. Z.	Mathematische Zeitschrift Springer Verlag, Heidelberger Platz 3, Berlin-Wilmersdorf.

CHANGE OF TITLE

Math. Tables Aids Comput.	Mathematical Tables and Other Aids to Computation. Title changed to: Mathematics of Computation [Math. Comput.] with issue dated January, 1960.

ERRATA

Abstr. 5853 (1956) line 3: for "S.-S. Min" read "S.-S. Minn".
Abstr. 905 (1957) line 2: for "M.B.P.Vittorelli" read "Palma Vittorelli,M.B.".
Abstr. 6465 (1957) line 3: for "J.C.Perbay-Peyroula" read "J.C.Pebay-Peyroula".
Abstr. 671 (1958) line 2: for "J.C.Roucayol" read "J.C.Roucayrol".
Abstr. 781 (1958) line 3: for "J.C.Perbay-Peyroula" read "J.C.Pebay-Peyroula".
Abstr. 6811 (1958) line 4: for "Myerson,A." read "Myerson,A.L.".
Author Index (1958) p. 946, column 1: under Poincelot,P. For "224" read "244".
Abstr. 6767 (1959) line 11: for "Seeman" read "Zeeman".
Abstr. 13383 (1959) line 12: for "11 200" read "11 112"
line 14: for "270" read "220"
line 30: delete "by"
line 31: for "5 μa" read "250 μa peak"
January 1960, Author Index: for "Boerboom,A.H.J." read "Boerboom,A.J.H.".
Abstr. 151 (1960) line 2: for "received" read "reviewed".

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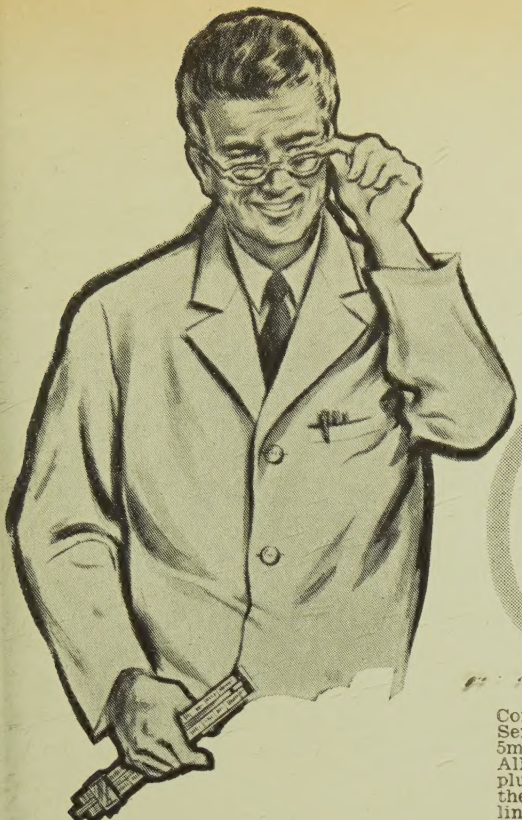

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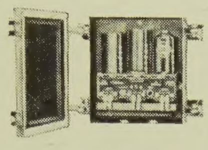

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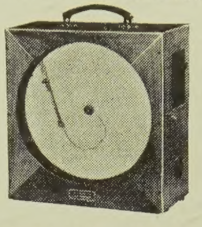

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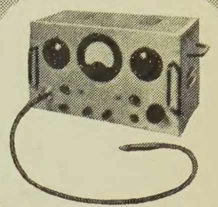

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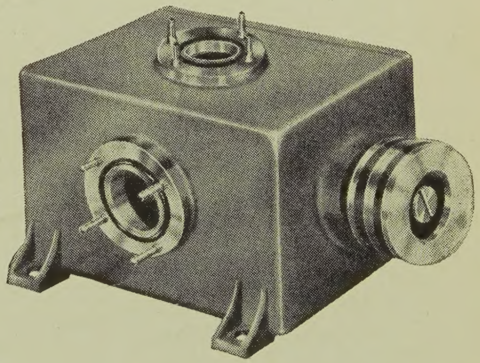

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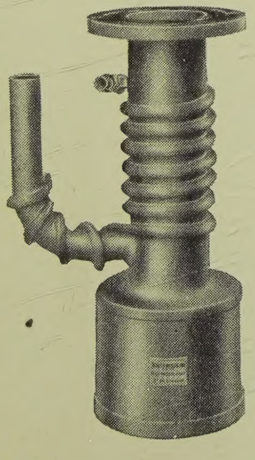

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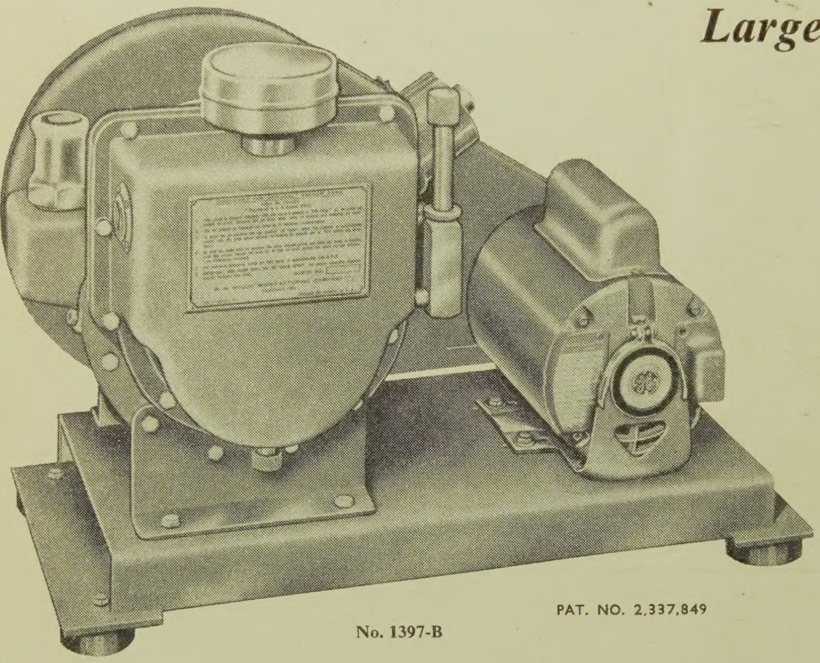

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